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Reports of Conferences

I have the honor to submit the first annual report for the reëstablished **Division of Administrative Officers** of Engineering Colleges covering the year 1942–43.

The Division was reëstablished at the Chicago meeting of the Council on October 26, 1942, and since an account of this action, as well as of the meeting of the newly created Division immediately afterward, is recorded in the JOURNAL of December, 1942, pages 285–317, I shall not give further details regarding the meeting.

An Executive Committee of the Division was appointed on November 13, 1942 as follows:

R. E. Doherty, *Chairman*
N. W. Dougherty
C. J. Freund
E. L. Moreland
D. B. Prentice
H. S. Rogers
Thorndike Saville
H. T. Heald
F. L. Bishop

The activities of the Division after the Chicago meeting related largely to problems created by the war. The then existing policy of Selective Service if continued would, it seemed, leave no engineering students for the war industries; the details of the contemplated college programs for engineering specialists for the Army and Navy were as yet unknown, especially in the case of the Army, and engineering colleges were not, in the opinion of the administrative officers, being appropriately taken into counsel by the Army in formulating policy and plans; and the plan of financial arrangements between the government and colleges were being framed without, again, the counsel of the colleges. The Executive Committee of the Division thus addressed itself to these highly critical problems. At the outset, however, it was embarrassed, because, being on the outside, it did not know fully the nature of requirements; it knew only that the critical issues were in process of being settled and had heard disconcerting rumors as to how they were being settled. By late December the situation was developing rapidly and it appeared that the Committee should meet promptly and determine what to do.

It met January 6, 1943 in New York at which time the situation was summarized as follows:

1. President Elliott's Committee of the War Manpower Commission was attempting to obtain deferment of engineering freshmen.
2. Engineering colleges that were to participate in the training program of the Army and the Navy were to be selected by a Committee of Army and Navy representatives, in compliance with rules and regulations for selection to be established by a committee appointed by the Chairman of the War Manpower Commission. This committee was understood to be practically finished with its

work. Its membership was as follows:

Owen D. Young, *Chairman,* Roderick Leland Carmichael, James B. Conant, Edmund E. Day, Clarence A. Dykstra, Robert G. Sproul, Arthur H. Sulzberger, William P. Tolley.

3. Plans for Army and Navy training programs were not completed and information concerning details of courses and curricula was not available.
4. It was likely that the facilities of all accredited colleges of engineering will be required for the Army and Navy training programs.
5. The War Manpower Commission contemplated the training of 200,000 special students in American colleges.

In view of the rapidly developing situation, the Committee decided that it should make certain recommendations to the government agencies concerned regarding the most critical of the problems the Committee reviewed. One of these related to payments to the colleges by the Government for educational services. Experience had been reported by certain colleges, and even by representatives of the War Department itself, that payment was to be determined on a lowest-bidder basis, and that some of the contracts that had been written for the early programs of the Army (not A.S.T.P.) seemed unreasonably low. The Committee therefore thought that it should propose that payment for educational service should be at least equal to the regular tuition fees, and such a recommendation was made. A fundamental change in Government policy, however, solved this problem, and an appropriate basis for contracts was later adopted.

Another recommendation related to the deferment of engineering students. I cannot do better than quote the resolution of the Committee.

> *RESOLVED* by the Executive Committee of the Administrative Division of the S.P.E.E. that the following unanimous judgment concerning procedure to be followed in the allocation of manpower resources for necessary technical war services be transmitted to the War Manpower Commission:
>
> Since reliable facts regarding the needs for replacements and additions to the professional engineering personnel of industry to maintain and to expand the war production program and the necessary supporting services are not presently available, and since the supply of such personnel is basically necessary to the support and success of the military program, the essential data describing such needs should be collected before final decisions regarding the selection and allocation of engineering trainees be determined.
>
> The survey necessary to determine industrial needs and to correlate them with military needs can be made in a reasonable period of time and should be immediately undertaken.
>
> In the meantime the required educational machinery should be kept operative. This will be accomplished in part by the directive of the W.M.C. concerning deferment of the three upper classes in engineering schools and by the deferment of the enlisted reserves as announced, but these

actions fall short of the immediate demand because the induction of freshmen through the Selective Service may have the effect of dispersing an essential part of the teaching staff into other war services from which they cannot be recalled should they subsequently be found indispensable.

To avoid disastrous consequences of this type, it is recommended that, in addition to the temporary deferment of sophomore, junior, and senior students, all freshmen now enrolled in engineering colleges be deferred until the end of the term following completion of the survey and of plans for training and assigning engineering personnel.

A third recommendation related to the establishment of an Engineering and Science Reserve Corps. The recommendation was as follows:

> There is evident necessity of providing a continuous flow of adequately trained engineering personnel for the Army, Navy, and civilian occupations essential to the war effort.
>
> The procurement of engineering and technical personnel for the armed services has been taken care of by the Army and Navy plans for the use of colleges and universities. The procurement of equally essential engineering personnel for war industry and technical agencies of government (as N.A.C.A., Bureau of Standards, C. & G. S., etc.) has not been adequately planned for.
>
> It is recommended that an Engineering and Science Reserve Corps be established immediately by the War Manpower Commission to consist, in the first instance, of those students in engineering colleges who maintain a satisfactory standing and are unable to meet the physical requirements for *officer personnel.* Members of this Reserve should have a status, and constitute a unit in the war effort, comparable to those assigned to the military services. Like those in military service their educational expenses and maintenance should be paid by the government.
>
> To provide a continuing flow of trained engineering personnel for Army, Navy, and civilian war effort it is further recommended that suitable machinery be established at the high school level to select and allocate those who are qualified for engineering and science training.

The Division had two meetings during the year. One was held in Washington, D. C. on March 18, 1943 at which the officers in charge of the Army Specialized Training Program and the Navy College Training Program were given an opportunity to explain these Programs to the administrative officers and the latter an opportunity to ask questions and discuss the Programs.

The second meeting was held in Chicago in connection with the Annual Convention. The purpose of this meeting was to have a discussion among the administrative officers of those whose institutions that had had experience in operating the new A.S.T.P. or in negotiating contracts with the N.C.T.P. Dean Daggett of Rutgers University collected information and presented a summary report regarding the A.S.T.P., and President Wicken-

den of the Case School of Applied Science did the same for the N.C.T.P.

These meetings were of a somewhat confidential nature, and the proceedings were therefore not printed.

The most important immediate result of the meetings was better understanding on the part of the administrative officers regarding some of the problems they still had to solve. Certainly the meetings indicated that many had not fully understood the situation. But there were additional important results. These meetings and other conferences with the representatives of the armed forces paved the way for complete coöperation between the A.S.T.P. and the S.P.E.E. which was effected promptly after the Chicago meeting, and an improvement of the already established good relations with the Navy.

ROBERT E. DOHERTY,
Chairman

The **Aviation Sessions** of the S.P.E.E. were held on Saturday, June 19, at 2 P.M. in Room M–11 and on Sunday, June 20, at 10:30 A.M. in Room M–6 of the Drake Hotel, Chicago. The program and papers for the meeting were arranged by Dr. Klemin. Unfortunately, Dr. Klemin could not be present at the meeting and, at his request, John D. Akerman of the University of Minnesota was acting chairman at the sessions. On June 19, 26 persons representing 24 institutions were present at the session.

The first paper to be presented was that of K. D. Wood of Purdue University entitled "Wartime Role of the University in Aeronautical Engineering Education." Mr. Wood, after presenting his paper, attracted considerable criticism concerning his pessimistic outlook of the work to be done by aeronautical engineering departments, particularly in view of new announcements by the Army and Navy that training in aeronautical engineering will be instituted.

Although enrollment in aeronautical engineering has dropped in all schools the same as in other departments due to the draft and industrial opportunities, institutions have found opportunities to do war time training in aeronautical engineering utilizing the faculty members and their facilities. Mr. Wood also aroused a great deal of criticism in regard to his disapproving statements about universities instituting educational programs connected with airports. This was particularly hard to understand because Purdue University has pioneered in this field, has done very good work and does not intend to curtail such activities. Why such discouraging comments were made by Mr. Wood remained unanswered by him.

The second paper was presented by A. S. Levens of the University of California entitled "What Can the Engineering Schools and the Aircraft Industries Do to Develop More Effective Engineering Personnel?" Professor Levens' paper was very encouraging and particularly his announcement of the five-point plan as advocated by the Vultee Aircraft Corporation, namely:

1. Undergraduate Scholarships.
2. Graduate Fellowships.
3. Employment Opportunities for Engineering Faculty during Vacation Periods.
4. Exchanges Between Engineering Faculty and the Corporation's Engineering Personnel.
5. Graduate Study and Research for the Corporation's Engineers.

The consensus of opinion was that interest and coöperation from the industry were very desirable and appreciated.

The third paper presented was that of C. T. Reid of the Douglas Aircraft Corporation of Santa Monica, entitled "A Revision of the Aeronautical Engineering Curriculum in the Light of Modern Aircraft Engineering Requirements." His paper caused considerable discussion concerning the type of curriculum he proposed the universities should carry in order to provide engineers for the air frame industry. Although considerable disagreement concerning detailed points was expressed during the discussions, one thing was very commendable, and that was that it was the first open suggestion from the industry as to what training they actually wanted in order that such a proposal would serve as a basis for discussion and building a program adaptable to the air frame industry in general. *Note:* Mr. Reid asked permission to revise his paper in the light of the discussions at the session.

After the discussion of Mr. Reid's paper a motion was made and passed unanimously "that the chairman appoint a committee from the industrial and educational institutions to suggest changes and improvements in the curriculum of aeronautical engineering in universities and colleges." The chairman made an announcement that he would make the appointment after some study of the problem.

L. R. Parkinson's paper, "Aeronautical Education in Light of Experience at Naval Aircraft Factory," was presented by title only.

The Sunday session was attended by 29 members representing 29 institutions. Professor Akerman acted as chairman. The first paper to be presented was that of H. W. Barlow of Texas A. & M. College, entitled "Aeronautical Relationships with the E.C.P.D." In his paper he criticized the lack of aeronautical engineering representation on E.C.P.D. accrediting committees. His criticism was supported by educational institution representatives at the meeting. A motion was made and passed unanimously "that the S.P.E.E. ask the Institute of the aeronautical sciences to appoint one of its members to the E.C.P.D. for the purpose of correlating accrediting educational institutions giving aeronautical engineering courses.

M. V. Barton of the University of Texas presented a paper entitled "Training for Production Engineering in the Aircraft Industries" written by M. J. Thompson and John C. Bowman of that University. This paper dealt mostly with the type of coöperation between aeronautical engineering institutions and industrial plants for short time training.

The third paper to be presented was that of E. S. Kavanaugh of the University of Notre Dame entitled "Aeronautical Engineering Curricula and Its Relation to Present and Future Needs of the Industry." His paper again raised the question of the need of improvements and changes in the aeronautical engineering curricula and was in line with the discussions raised by Mr. Reid's paper.

A. C. Willard, president of the University of Illinois, during the discussions gave a short resumé of the reasons why the University of Illinois is undertaking a large aeronautical and aviation medicine program, the main reasons being that the study of physiological, sociological and economical questions raised by the advancement of military and civilian aviation re-

quires a great deal of study, research and training.

The last paper presented was "The Relationship of Aeronautical Engineering Education to the Allied Sciences" by John D. Akerman of the University of Minnesota. His paper deviated from the immediate activities and needs and discussed the need for training men who would be leaders and creators in the aeronautics field, utilizing the developments in other sciences for the proper advancement in the aeronautical field, and vice versa the aeronautical field provides new uses, application, and requirements for new developments in other fields of sciences. He states that the function of educational institutions is two-fold, first, to provide rank and file workers as advocated by Mr. Reid, and second, leaders who would create and provide the work for the rank and file workers.

J. D. AKERMAN

Chemical Engineering.—The program consisted of two technical conferences, a dinner meeting and two brief business meetings with, despite wartime restrictions, about 35 members attending the various functions. "The Army and Navy War Programs" and "Adjustments in Chemical Engineering After the War" were the general topics of discussion at the conferences.

The principal speaker at the annual dinner meeting was Paul D. V. Manning, Director of Research, International Minerals and Chemical Company, who spoke on "What Industry Expects of Chemical Engineers." Dr. Manning emphasized the continuing need of well-trained men in industry and outlined some of the problems facing us after the war. He made a strong plea for men developed to help solve the broad social and economic problems confronting civilization and deplored the taking by Selective Service of chemical engineers from schools and colleges who are so vitally needed in industry. Following this paper a lively discussion arose, led by Webster N. Jones (Carnegie Tech.), R. C. McBride and H. McCormack (Illinois Tech.) on the demerits of the Kilgore Bill.

Preceding the first conference on Saturday, June 19, the annual business meeting of the Division was held, Acting Chairman R. A. Morgen (Florida) in the chair. About 35 members were present. The minutes of the preceding meeting appearing in the JOURNAL OF ENGINEERING EDUCATION, 33, 352–7 (1942, Dec.), were approved as published.

The treasurer reported there were no expenditures to date and that the balance of funds as of June 1 amounting to $62.80 remained as at the end of the previous year. No special assessment of members was recommended for the coming year.

The Publications Committee, R. N. Shreve (Purdue), Chairman, reported that three papers of the preceding meeting had been published as recommended as well as the secretary's annual report. He stated that the joint publication project tentatively worked out with S. L. Tyler, Executive Secretary, American Institute of Chemical Engineers, could not be undertaken at this time owing to wartime restrictions. J. H. Koffolt (Ohio State) recommended that the committee investigate and report on printing and binding the collected papers of the current meeting. About 250 copies of collected papers of the California meet-

ing had been distributed at a cost of about $25.

The Resolutions Committee, composed of C. C. DeWitt (Mich. State), Chairman, and J. H. Arnold (Iowa), presented the following resolution:

Whereas the U. S. Senate bills Numbers 607 and 702 as introduced by Senator Kilgore provide for the complete regimentation of scientific activities and research of every sort under political control, and whereas such control would seriously and adversely affect the freedom of thought and work of every scientist, engineer, and teacher of science and engineering, therefore be it resolved that it is the sense of the collective thought of the Chemical Engineering Division of the S.P.E.E. assembled at Chicago, June 18–20, 1943, that every legal means of defeating these measures be actively and aggressively employed. After studying these bills, each member is therefore urged to write to his senator, and in his own words give his personal reasons why these bills, or modifications thereof, should not be passed.

Adoption of this resolution was moved by H. L. Olin (Iowa), seconded by J. H. Koffolt (Ohio State), and passed.

The Nominating Committee, consisting of past chairmen of the Division, presented the following slate of officers for the year 1943–1944:

Chairman—R. A. Morgen (Florida)
Vice-chairman—C. W. Borgmann (Colorado)
Vice-chairman—T. S. Crawford (Rhode Island State)
Secretary-Treasurer—E. M. Schoenborn (Delaware)

These nominees being unopposed, the secretary was instructed to cast one ballot for the slate.

Papers and Discussion

Saturday afternoon, June 19, 1943.
The Drake Hotel

"The Army and Navy War Programs"

A. P. Colburn and E. M. Schoenborn (Delaware), "The Development of the Chemical Engineering Curriculum under the Army Specialized Training Program."

C. A. Mann (Minnesota), "Army Specialized Training in Chemical Engineering at the University of Minnesota."

Lt. Col. Fred H. Pumphrey (A.S.T. Division), "What the Army Expects of Chemical Engineers."

Harry McCormack (Illinois Tech.), "Chemical Engineering Education in the Navy Program."

C. F. Prutton and C. O. Miller, "Chemical Engineering and the Civilian Student."

Chairman Morgen, on opening the conference, commented on the interest which the A.S.T. Program and its problems had aroused among engineering educators and stressed the need for consideration also of the post-war problems facing the profession.

E. M. Schoenborn (Delaware) outlined the development of the A.S.T. curriculum for chemical engineers and discussed the objectives, limitations and problems involved. He pointed out that the current program is designed to give the best training possible under the limitations imposed by the Army in the shortest possible time. A number of suggested curricula were proposed for consideration and discussion. It was pointed out that the objectives of the A.S.T. Program are not the same as those for training professional chemical engineers.

As one actively engaged in teaching chemical engineering to 119 trainees,

C. A. Mann (Minnesota) related some of his experiences with the A.S.T. Program at the University of Minnesota. He outlined some of the various difficulties that had to be overcome and gave a most encouraging report on the actual workings of the program.

A letter from G. M. Gleeson (Oregon State) on his experiences with the A.S.T. Program was read by the chairman.

Lt. Colonel Fred H. Pumphrey, Chief, Engineering Section, Curricula and Standards Branch, Army Specialized Training Division, gave an off the record discussion of the A.S.T. Program especially as it pertained to chemical engineering and then answered numerous questions put to him by members of the group. He stated that the A.S.T. Division would be happy to have the comments and suggestions of those interested in the success of the undertaking and would give them their earnest consideration.

Although a prescribed Navy program for chemical engineers does not exist, Harry McCormack (Illinois Tech.) commented on the course and subject matter which might be included in a chemical engineering curriculum for certain Navy personnel.

The status of the civilian student during these critical times was discussed by C. O. Miller (Case) who described how students at present available might be used in furthering current war research and how such a plan was being successfully carried out at Case.

Sunday morning, June 20, 1943.
The Drake Hotel

"Adjustments in Chemical Engineering After the War"

R. N. Shreve (Purdue), "Evaluation of A.S.T.P. Courses."

J. S. Whitwell (Princeton), "Post War Educational Problems."

O. A. Hougen (Wisconsin), "A Graduate Program for Chemical Engineers."

The second conference was called to order at 10:30 A.M. by Chairman Morgen, who, after some preliminary announcements, introduced the first speaker, R. N. Shreve. Dr. Shreve discussed the question "What will be the characteristics of the men returning from the war?" Since they will in all probability be more mature, more earnest and possess a greater incentive to do good work, our curricula may have to be revised to meet new requirements, as by the initiation of suitable refresher courses. He also pointed out the effect of continuous teaching on the instructional staff and stressed the need of time for professional advancement.

"Post War Curricula Adjustments" was the topic of the paper by J. C. Whitwell (Princeton). Rehabilitation of students after the war and the handling of many new students pose serious problems to colleges and universities especially in regard to courses and subject matter. An extension of our present generalized methods of teaching should be retained and too great a tendency toward specialization avoided.

O. A. Hougen (Wisconsin) emphasized the need for strong graduate programs in chemical engineering particularly in the post-war period when so many students will be returning to continue their studies. His plea that chemical engineering should be taught by the chemical engineering staff and not by the staffs of other departments received commendation of the entire group.

After discussion of the various

papers presented, the meeting was thrown open to discussion of the A.S.T. Program for chemical engineers. Whitwell, Shreve, and Koffolt entered strong pleas that the present A.S.T. course, Chemical Engineering Problems, be retained. Koffolt also supported the retention of Chemical Technology.

Upon motion of C. C. DeWitt, seconded by R. N. Shreve, it was unanimously agreed that Qualitative Analysis should be changed to the Third Term of the Basic Phase in place of Engineering Drawing. Engineering Drawing would then be given in Term 4. A. B. Newman moved and C. C. DeWitt seconded the following resolution which was unanimously carried:

It is the consensus of opinion of the Chemical Engineering Division, S.P.E.E., that any A.S.T. curriculum for chemical engineers should be put on an eleven-quarter basis of sufficient caliber to lead to the bachelor's degree. It is the feeling of this group that men who would be withdrawn at the end of seven terms for technical service in specialized branches of the Army would be better prepared than those under the current program.

The Resolutions Committee, C. C. DeWitt and J. H. Arnold, presented the following resolutions which were adopted:

Whereas the Chemical Engineering Division of the S.P.E.E. has enjoyed the courtesies and hospitality extended by the host institutions, Illinois Institute of Technology and Northwestern University, at this 50th Anniversary National Meeting of the S.P.E.E. at Chicago, June 18–20, 1943, therefore be it resolved that we express our appreciation to these agencies for their splendid teamwork which has so evidently made possible our coming together under these pleasant circumstances and appointments. Be it further resolved that we collectively cause to be spread on our minutes and transmitted to the host institutions and their local committees a copy of this resolution.

Whereas all those present have so thoroughly enjoyed the activities and programs which the officers of this Division have so carefully and thoughtfully provided, therefore be it resolved that this Division records upon the minutes its appreciation of their efforts.

E. M. SCHOENBORN,
Secretary-Treasurer

The activities of the **Committee on Comprehensive Examinations** for 1942–43 were mostly nominal, consisting essentially of holding an organization together that can take up the work where it ceased a year or more ago, in accordance with plans then made.

During the year, some plans were outlined for the formation of a Division of Educational Methods which might encompass the work of the present Committee on Instructional Methods and its subcommittee on Visual Education, and the work of the Committee on Comprehensive Examinations, and thus place the work of both committees on a permanent basis—a status long desired by the Committee on Comprehensive Examinations.

The proposal was discussed with Dr. Ell, Chairman of the Committee on Instructional Methods, who is entirely favorable to such an arrangement. Dean White discussed the proposal informally with several officers of the Society and members of the Executive Council. The question was on the agenda for consideration by the Executive Council at the Chicago meeting but, owing to pressure of other matters, was not presented for consideration.

The Committee was represented at the Chicago meeting by Dean White,

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The Committee was represented at the Chicago meeting by Dean White,

but had no conference on the schedule.

The Committee does not foresee any possibility of more than nominal activity during the war, but hopes that its organization may be held together by sufficient continuity of membership to enable it to proceed according to plan after the war.

H. W. BIBBER
W. E. HOWLAND
C. V. MANN
C. T. OLMSTED
C. L. SVENSEN
G. S. TIMOSHENKO
W. C. WHITE
P. A. WILLIS
R. H. FRAZIER, *Chairman*

The **Electrical Engineering** group dinner was held Friday, June 18th, in the Orrington Hotel in Evanston, and was followed by an inspection trip through the Northwestern Technological Institute laboratories.

Professor Coover presided at the meeting on Saturday, June 19th. In the absence of M. M. Boring of the General Electric Company, Ben S. Willis of Iowa State College led a discussion on "Training Women for Industry." Professor Willis reported on results of a course in Electrical Engineering taught to a class of Home Economics seniors majoring in household equipment, as well as some reactions of instructors teaching in the Curtiss-Wright program at Iowa State.

Mr. Willis stated that his contribution to the discussion was the assurance to anyone faced with the problem of a class of women in engineering subjects that, given the proper incentive —such as the certainty of a job in industry—girls can, and will, do work of the same calibre as that done by the regular engineering students. The only handicap suffered by girls in engineering courses is lack of engineering background; *i.e.*, the fact that girls have not spent their youthful leisure time tinkering with mechanical devices as have boys who normally enroll in engineering.

Industry is calling on the colleges to assist in the training of women in two ways:

1. By sending employees to the college for a course of study prescribed by the company.
2. By suggesting elective courses in engineering subjects for women in regular college courses.

Mr. Willis had no authority to report on the Curtiss-Wright program at Iowa State College, and therefore could only give the reactions of instructors with whom he had talked. All of these conversations supported the conclusion that the women were carrying regular engineering courses satisfactorily, their difficulties being of the same nature and magnitude as those of boys at the same point in their engineering course.

The course offered as an elective for regular women students is equivalent to the regular course in electrical engineering for non-electrical students. It is a 5-credit course for two quarters and includes a 3-hour laboratory period each week. To make up for the lack of background more than the usual number of demonstrations are used and nearly double the number of laboratory tests performed. Otherwise, the type of instruction and difficulty of assigned problems and laboratory tests are the same.

In conclusion, it was suggested that there are as many potential engineers among women students as among men.

There is no reason why engineering aptitude should be limited to the male sex. The performance during the next few years of the many women going into industrial positions will be well worth watching.

Colonel Charles N. Sawyer, Commanding Officer of the Signal Corps School, Sixth Service Command, headed the second panel with a description of Signal Corps Training programs which he instituted in the Sixth Service Command. These schools were started in April, 1942, and have had a combined enrollment of over 17,000 students. In all, 14 schools were set up providing for training on six different levels. The following is a list of the courses, duration of instruction and number of graduates in each, as of July, 1943.

	Length of course	Number of graduates
A. Mechanic Learners	12 wks.	2,700
B. J.R.T. Telephone	12 wks.	1,111
C. J.R.T. Radio	12 wks.	4,933
D. Pre-Radar	12 wks.	4,202
E. Radio and Ultra-High-Frequencies	20 wks.	1,126
F. Radar	8 wks.	720

The Mechanic Learners and J.R.T. Schools are primarily concerned with developing radio and telephone technicians. Elementary courses in mathematics, electricity and magnetism, and radio or telephone theory are given. Considerable emphasis is placed upon practical experience with field equipment in these courses. The pre-radar school provides for training in mathematics including some calculus, electricity and magnetism, physics, and radio. This was intended as a feeder course for the higher level courses. The radio and ultra-high-frequency courses included comprehensive courses in mathematics, A.C. circuits, radio, and ultra-high-frequencies. In this course, students were given extensive laboratory experience on commercial receivers and transmitters, as well as a wide variety of ultra-high-frequency experiments. A radar school was set up by the Sixth Service Command for the purpose of giving instruction on typical radar units.

Students for these schools were recruited from civilian ranks. All students were required to have high school graduation and an Army General Classification Test score exceeding 120, which is 10 points higher than the minimum required for officer candidates. Classifying examinations were given in mathematics, electricity and magnetism, and radio to determine the level which each student should enter. Upon completion of a course, students were permitted to take qualifying examinations for the next higher level. It was therefore possible for a student to enter at the lowest level and work his way up to the higher level courses.

Upon completion of the training, 162 men received commissions before entering active duty. Others have been appointed to non-commissioned or commissioned ranks since entering active duty. A number of the graduates are engaged in research work in the radiation laboratory at M.I.T., Aberdeen Proving Ground, the Geophysics laboratory, and the Radio Research laboratory at Harvard University. A large number of graduates are now in active duty on the fighting front.

The following officers were elected for the ensuing year:

Chairman: Morland King, Lafayette College

Vice Chairman: A. D. Moore, University of Michigan

Secretary: A. B. Bronwell, Northwestern University

The **Committee on Engineering Economy** has managed to keep in touch with its members in spite of war conditions, but little has been accomplished during the year beyond reaffirming the desirability of promoting coöperative discussions of the fundamental technical principles of engineering economy in order to produce ultimately a record of the best thought in these matters. This activity awaits a little more leisure among those interested, although it is hoped that a beginning can be made by a subcommittee this coming year so that a definite plan can be presented to the Council for its approval in the not too distant future.

The conference at the annual meeting in Chicago was well attended considering the times. Approximately twenty of us gathered in round-table discussion even though the printed program announced only an informal meeting with no scheduled papers. D. O. Bowman, Executive Assistant, Price Department, Regional Office of O.P.A., on leave from the University of Michigan, had planned to join our round-table and present a paper entitled "Economics and Engineering Education" in order to focus our discussion upon the future relations of the teaching of engineering economy and the teaching of general economics to engineering students. He and his alternate, Mr. Christenson, also of the Chicago O.P.A. office, were unfortunately called away from Chicago on government business and last minute arrangements had to be made for the reading of his paper by the Chairman. This paper was presented at the beginning of the conference and served as the basis for a lively discussion by those present. Those contributing were: A. H. Lovell, University of Michigan; F. C. Dana, Iowa State College; G. L. Tuve, Case; H. G. Thuesen, Oklahoma A. & M.; Harry Rubey, University of Missouri; R. H. Simonds, Yale Brozen, Marie W. Spencer, Illinois Institute of Technology; M. O. Starr, University of Illinois; V. D. Prian, Fenn College; E. K. Springer, University of Wisconsin; W. R. Spriegel, Northwestern University; Warren Raeder, University of Colorado, and others. It was agreed that further attention to this subject should be given at future conferences.

Some discussion was given over to the matter of forming a subcommittee for the active consideration of engineering economy principles as discussed above. Encouraging signs of an immediate start on this work were forthcoming. Also the matter of the relation of the teachers of engineering economy and of general economics to post-war economics and planning was discussed briefly. The importance of the impact of economic history upon the teaching of engineering students was also emphasized. The meeting was adjourned shortly after noon and continued informally for some time thereafter. Regret was expressed that many committee members and others who usually attend our annual sessions were unable to be present at this conference.

EDMUND D. AYRES,
Chairman

The **Mechanical Engineering Division** of the Society had a successful series of conferences and meetings which opened with a dinner and conference the evening of Friday, June 18th. H. O. Croft presided and Baldwin M. Woods of the University of California gave an extremely interesting and thought-provoking talk on the

subject of "Engineering and Planning in America." The talk was followed by a sustained period of discussion.

Preceding the afternoon meeting of Saturday, June 19th, a business meeting of the Division was held and officers elected for the 1943–44 year. At the conference it was unanimously decided to combine the Machine Design and Manufacturing groups with the Heat Power and Laboratory groups so that all groups could hear the three fine papers scheduled.

Norman B. Hindle of Chicago, Assistant Secretary, American Foundrymen's Association, spoke on the subject of "Practical Aspects of Casting Design for the Student and Engineer."

Arthur Simon, of Milwaukee, Wisconsin, Patent Attorney and Engineering Consultant, spoke on "Patents and Progress."

T. R. Thoren, Chief Development Engineer, Thompson Products Co., Inc., of Cleveland, Ohio, spoke on "A Research Engineer Looks at Mechanical Laboratory Instruction."

All the papers were well received and followed by sustained discussion. These papers are being prepared for printing in the JOURNAL and should represent a real contribution to the literature.

B. H. Jennings of Northwestern University and D. W. Nelson of the University of Wisconsin presided jointly at this meeting.

On Sunday morning, June 20th, a combined Sections meeting was held at which Lieutenant Colonel Blake R. VanLeer spoke on "The Mechanical Engineering Program of the Army Specialized Training Division." During the discussion period following the talk, Lieutenant Colonel Fred Pumphrey was present and joined in answering some of the many questions proposed. John I. Yellott of the Illinois Institute of Technology presided.

The officers elected for the year 1943–44 are:

Executive Committee:
- B. H. Jennings, *Chairman,* Northwestern University.
- P. E. Kyle, *Secretary,* Massachusetts Institute of Technology.
- Colin Carmichael, *Editor,* Mechanical Engineering Division, with "Machine Design."
- N. P. Bailey, General Electric Company.
- L. M. K. Boelter, University of California.
- G. B. Carson, Case School of Applied Science.
- D. G. Ryan, University of Illinois.

Heat Power Committee:
- L. M. K. Boelter, *Chairman,* University of California.
- F. L. Schwartz, University of Michigan.
- C. O. Mackey, Cornell University.

Mechanical Laboratory Committee:
- N. P. Bailey, *Chairman,* General Electric Company.
- F. C. Stewart, Pennsylvania State College.
- B. E. Short, University of Texas.

Machine Design Committee:
- D. G. Ryan, *Chairman,* University of Illinois.
- C. H. Young, Cooper Union.
- R. R. Slaymaker, Case School of Applied Science.

Manufacturing Process Committee:
- G. B. Carson, *Chairman,* Case School of Applied Science.
- S. J. Tracy, Col. City of N. Y.
- F. S. Bauer, University of Colorado.

BURGESS H. JENNINGS
Chairman

Mechanics Division.—About twenty members attended the informal luncheon in the Lantern Room of the Drake Hotel, Chicago. Following the luncheon about forty members assembled for a short business meeting in which Charles O. Harris, Illinois Institute of Technology, and Warren E. Wilson, Armour Research Foundation, Chicago, were elected to the Executive Committee of the Division to serve until 1947.

After the business meeting the conference started. The first paper was a "Report on Achievement tests in Mechanics" presented by Jasper O. Draffin of Illinois University. A lively discussion followed this report after which it was agreed to continue the study of achievement tests if conditions warrant and to request additional funds to finance the program. (This request was later granted by the council.)

The second paper, "Electrical Models in the Teaching and Application of Vibration Theory," by E. N. Kemler and C. R. Freberg of Purdue University, was presented by Dr. Kemler. Dr. Kemler supplemented his talk with an instrument in which he demonstrated the solution of a single mass system with damping and also a multimass system with damping. This paper proved very interesting and considerable discussion followed. Many stayed after the meeting for further demonstrations and to get a "close up" of the apparatus.

Following the conference the Executive Committee of the Mechanics Division met. Those present were Draffin, Everett, Fairman, Withey, Harris, and Wilson. Seibert Fairman was elected chairman and tentative plans for the next years conference were discussed.

SEIBERT FAIRMAN,
Acting Chairman

Engineering Education in the Soviet Union*

By J. G. TOLPIN

Universal Oil Products Company, Chicago, U. S. A.

Industrial Background

We witness an unprecedented upheaval of industry in a country which was known for centuries as a backward agricultural country. Today, after two years of mechanized war requiring a constant flow of manufactured weapons and other articles for highly specialized and precise use, an assertion is justified that the industrialization of the Soviet Union, which was carried out in the form of a planned program known as the Five-Year Plans, contributed a very important, if not a decisive, factor in winning this war for the Allies and thus in saving the world. It is quite natural, therefore, to inquire who the man is behind this industry, the man who builds and operates it, what his qualifications are, how he is being trained for his job.

The full significance of this question is shown only by a comparison, even though superficial, of the industry in Russia before the first world war with its present state. This comparison, which I shall attempt, and my remarks about the education of the present day Soviet engineer are based largely on consistent reading of the Russian chemical and engineering literature, which is a part of my professional work; this was supplemented by some material taken from special literature on higher education in the Soviet Union, and recent contacts with Soviet engineers and educators, as well as American engineers who worked in the Soviet Union. The statistical data reported below have been taken from official Soviet publications. My personal information on the subject is limited to only the initial period of the existence of the Soviet Union up to the time when, in consequence of the Soviet-Polish Peace Treaty of 1920, my native town became a part of Poland, after which I left the Country.

The industry of U. S. S. R. is today probably a dozen times as large as the Russian industry of 1914; no prewar statistics apply today, but already in 1939 the net increase was expressed by a figure of 908 per cent on its output for 1913, considering the same territory in both cases, and the increase for the period between 1933 and 1939 was nearly 240 per cent.

The wealth of natural resources in Russia is well known. Exploration during recent years greatly added to this knowledge, and Soviet geologists regard the oil resources of U. S. S. R. as amounting to over 50 per cent of the total world resources today. The resources of potassium mineral deposits in north European Russia and in Kazakhstan are stated to be the largest in the world. The prospected resources of iron ore, coal and other mineral deposits are rapidly expanding. Reports of this prospecting come

* Address delivered at the 50th anniversary meeting S. P. E. E., Chicago, Ill., June 18–20, 1943.

in even at this time, during the war, and as an example, I would like to quote the prospected coal resources in the Pechora region in northeastern European Russia. In a recent report I used a 1939 figure, which is 36,500,000,000 tons, which I had to correct while writing this report, since a new figure was published in the meantime by the Academy of Sciences resulting from recent exploration, raising it to 120,000,000,000.

Despite this abundance of resources, the first world war found Russia with an industry utterly unprepared to support any war effort. Russia at that time had no explosives industry. Some products, such as potash, used to be imported from Germany, where they were made by refining Russian crude products imported into Germany. The pharmaceutical industry was non-existent, as was the industry of nitrates and the plastics industry. Other industries, such as the aniline dye industry, were controlled by German interests. The oil industry was largely controlled by foreign capital. Some industries which showed a pronounced growth at the beginning of the 19th century were later on depressed as a result of the policies of the tsarist Russian government. For instance, as early as the end of the 18th century, Russia exceeded, according to some authorities, England, France, U. S. A. or Prussia in production of pig iron. These countries, however, increased their production during the 19th century at a much more rapid pace than the agricultural Russia did.

However, in the laboratories of Russian universities and polytechnic schools research was carried out on a scale much higher than the facilities for industrial realization of the results of this research would warrant.

Numerous examples are known of important discoveries and inventions in the field of chemistry, electrical and other branches of engineering which found no application in Russian industry of the pre-revolution era. Some of them stimulated important developments in the industries of neighboring countries, notably Germany. One of the outstanding examples of this type is the development of the method of reduction of nitrobenzene to aniline made by N. N. Zinin in 1842 and greatly used in Germany and other countries from which Russia imported aniline derivatives.

Many engineers and other people with specialized higher education never employed their knowledge in industry. The ore, coal, oil and mineral deposits of the Ural mountains and Siberia remained unused to a large extent and industry was located for the most part close to the western borders of the Country and was open to military attack.

Much of this situation was radically changed in consequence of the industrialization drive. Today we live through a much more opportune moment to understand many motives and factors of this painful but decisive drive. It may be said that the Soviet Union had built up its industry in a large measure as a part of its war effort, the demonstration of which we see only now.

As early as 1931, Stalin expressed the aim of the entire Soviet industry as follows: "We are lagging behind the most advanced countries by 50 to 100 years. We have to cover this distance within 10 years. Either we will accomplish this or we will be crushed."

The familiar features of transformation of a peacetime to a wartime econ-

omy which we observe in this country today, such as scarcity of many materials, difficulties in adequate distribution, priorities, problems of training and distributing labor resources, strenuous efforts to draw women into industry, and, above all, preference for wartime necessities over consumer goods, which are so well known today in every country at war, always characterized the economy of U. S. S. R. in reconstruction.

To be sure, there were failures. The imagination of the young and radical managers of industry was fired with the slogan "to reach and overtake the capitalist countries" in production. They operated with inexperienced labor and pressed for quantity production. Red tape in offices is a big hindrance there as everywhere else. All this was responsible for inferior quality of goods in many cases and for delay of needed improvement. However, I find these causes openly discussed and criticized in articles in the Soviet technical press, in which the authors also pride themselves and praise the management of industry for important achievements. At times self-criticism even becomes a policy of social behavior and is overdone. As to the problem of quality versus quantity, the performance of Soviet planes, artillery and tanks is said to be good enough to support the view that in the critical industries there was no lack of attention to quality.

Although some reconstruction was made previously to institution of the five-year plans, the spectacular growth of Soviet industry was achieved under these plans. The first five-year plan was executed during the four-year period of 1928 to 1932. The second lasted through 1937 and the third was to be completed in 1942. The plans embodied detailed schedules for development of all parts of national life, including industry, agriculture, education, transplanting parts of the population and industry, etc. The center of the population was gradually but consciously shifted far to the east, which was revealed by the national censuses carried out in U. S. S. R. in 1926 and 1939. While the total population increased only by 15.9 per cent, the eastern regions, including Ural and Siberia, showed a growth of the population amounting to 33 per cent, and this was especially pronounced in urban industrial centers, which showed in some instances much higher increases.

Some of the most important products may be used to illustrate the general rise of Russian industry during this time. When figures are compared accounting for the Russian territory of 1913 which was included in the territory of U. S. S. R. as of January, 1939, it is seen that the actual rise of production from 1913 to 1937 and the planned rise for 1942 were:

	1913	1937	1942 (planned)
Coal (millions of metric tons)	29.1	128	230
Iron ore (millions of metric tons)	9.2	27.8	
Oil (millions of metric tons)	9.1	28.4	48.5
Sulfuric acid (metric tons)	121,000	1,666,000	
Electrical energy (billions of k.w. hours)	1.9	36.4	75
Locomotives	664	1,214	2,090

The growth of civil aviation is shown by the length of airway lines, excluding overlapping sections, which was 9,326 miles in 1928 and 45,600 in 1935.

U. S. S. R. produced in 1938 all types of alloys stable to corrosion by various chemicals, although the number of grades of these alloys was considerably smaller than that made in foreign countries.

There was no automobile industry in Russia before the first world war, and only two assembling plants existed in the Country at the conclusion of the war. The industry started with the plant in the city of Gorkiĭ, which started operation in the beginning of 1932, producing Ford automobiles 1930 model. In 1938 they occupied the fifth place in the world with respect to production of all types of engines and the second place in the world with respect to production of trucks. New models were being prepared immediately preceding the outbreak of the present war, and a new big automobile plant was under construction.

In the drive for expanded production it was necessary to copy many foreign models, examples of which, were observed by non-Russian engineers visiting Russia in recent years. The imitation, however, is soon followed by adaptation to the conditions prevailing in the Soviet Union.

An American engineer traveling in U. S. S. R. visited the Dneprostroĭ hydroelectric plant. Of the three big identical turbines in operation, two were imported from the United States when Col. Cooper supervised the construction of the project and a third was made in Russia and subsequently installed.

As a further example of this trend construction of the automobile M–1 may be cited. This very widely used automobile constitutes a modification of the four-cylinder Ford model of 1934. The changes were made mainly with a view to adapting it to the more severe conditions of the Russian roads.

Many branches of industry are practically new, as, for instance, the chemical industry; of the output for 1937, only 7.3 per cent came from plants which existed before the revolution. The third five-year plan has been termed the chemical five-year plan, indicating the intended special development of this industry, which was to increase its production 2.4 times over that achieved in 1937.

Labor

Training of workers is embodied in all Soviet plans for expansion of the industry. The agricultural population of the country showed a drop from 80 per cent in 1913 to 55.5 per cent in 1939, the non-agricultural wage earners amounting to 37.4 per cent. In the latter category industrial workers and employes are included, the number of which was reported in 1938 to have reached 28,000,000 against 11,200,000 for entire Russia in 1913, which included 2,618,000 workers in the processing industries. The total population of Russia was 139.3 millions in 1913 and 170.5 millions in 1939. The methods used for insuring adequate supply of labor were stated to have been inefficient until 1938. The quota for the transfer of young people from agriculture to industry was given by Stalin as 1.5 million per year.

In the situation which prevailed soon after the revolution of 1917, when both the political and the industrial life of the Country were under duress, the accent of the ruling organizations was naturally placed on the youth as the

most promising object of reeducation. Young people were given responsible administrative positions in the growing industry, and especially those positions which required much devotion to duty, even though without personal authority. For instance, it was stated that among the workers engaged in construction of the Moscow subway, 47 per cent were younger than 23 years.

With the progress of industrialization and technical education, it became apparent that the slogan "technique will solve all problems" should be substituted by a new one—"personnel will solve all problems." The youth which was taught to study had to be warned against developing a mechanical attitude toward complicated problems of the growing industry.

It may truly be said today that the emphasis on training the human reservoir was the most decisive aspect of the industrialization of the Soviet Union. The greatest single inhibiting factor in growth of industry in U. S. S. R. consisted in the lack of an industrial background in the Country. Growing children saw no mechanical objects, no machinery around them, had no chance to learn by experience, by tinkering with mechanical appliances, which greatly affected their work even if they had received engineering training. Youth organizations, various forms of clubs, juvenile literature, games, sports, plays, the wall newspaper, a form of bulletin board with current news and articles used in schools and clubs—all were utilized for this purpose; posters used for calling the attention to correct use and care of machinery, for indoctrinating elementary sanitary and hygiene rules and for similar purposes have a well conceived advertising approach.

As an example of the juvenile literature serving the above purpose, the journal entitled *Tekhnika Molodezhi* (*Technology to the Youth*) may be cited, in which information on technical subjects of current importance is given in illustrated and easily understood form. Since the war spread to U.S.S.R., this journal is devoted to engineering of war, and the use of various appliances in civilian defense is described. Some information about the weapons used by the enemy is published which is of interest to the youth who may become guerillas. Further, vitamins, victory gardens, women in plants are featured, with their biographies; the performance of British and American Lend-Lease equipment, such as trucks, is described, indicating its successful performance. In this literature the youth is taught to love its tools, and when it comes to military service, to love its weapons, to treat them as important friends. I found a quotation of the first remark V. Chkalov, one of the trans-Polar fliers to the United States in 1937, is alleged to have made when he was overwhelmed by the reception of the Americans, as his plane came to the ground and he was asked to same something, "Put some blocks under the wheels of the plane."

It was also necessary to put before the eyes of youth and the country at large examples of the most devoted workers. Production had to be increased at all costs, and so the Stakhanovite movement was born, payment of wages based on piece work and heroes of production widely publicized and glorified.

Alekseĭ Stakhanov, a miner who exceeded all standards of production by simplifying certain operations and by devotion to work, was made the hero of the movement bearing his name

since 1935. Stakhanovite groups were founded in all shops, mines, factories, laboratories, schools and universities. Methods of efficient production are being developed everywhere and norms of production in all fields are constantly being raised by Stakhanovites. The chemical industry was reported in 1940 to have 76 per cent of its workers exceeding the regular norm of production by 31.6 per cent, but the rest were falling behind the schedules. Since the payment for services depends on the output, the Stakhanovites usually earn more than ordinary workers, in addition to the individual prestige they get.

The term "eminent workers" is frequently applied to those who distinguish themselves by quality or quantity of production. Their pictures appear in trade journals and general papers. Medals and other decorations are given to these heroes and other means of inducement applied for others to follow their examples.

Occasionally, advanced study of these publicized medalists is being specially attended to. The Timiryazev Agricultural Academy had among its students for the year 1938–1939 32 workers decorated for special effort and 15 deputies of the Supreme Soviet.

Another method of raising production consists in competition between individuals or organizations. These are known as Socialist competitions. Competition of "eminent blacksmiths" in making parts of machinery for war equipment is reported, and also competition of professors for the best textbook. Also in schools competitions for a scientific or pedagogical objective are quite common. In the journal *Vysshaya Shkola* (*Higher Education*) there appeared in 1939 an account of a "mathematical Olympiad," the fourth of its kind, the first having taken place in 1935. Celebrating the 20th anniversary of the October Revolution, the Academy of Sciences of U. S. S. R. organized six years ago a contest of young scientists for the best piece of research work in a number of fields in which over 3,000 people participated, including 227 college instructors.

Not only is this form of competition encouraged, but occasionally criticism of unsatisfactory organization of competition between members of important trades or professions found.

In connection with these contests, it may be worthwhile to mention that at the end of 1939 a series of Stalin prizes were instituted by the government of the Soviet Union for achievements in sciences and arts and important inventions. These prizes range from 100,000 to 25,000 rubles each.

In some cases, two persons or groups enter into an agreement stipulating that each is to contribute his share to a common objective. For instance, an agricultural school will agree to supervise a special crop which is to be tended by a neighboring collective farm, the second party to the deal. These agreements usually receive as much publicity as is possible to obtain for them.

Among the latest measures to insure an adequate supply of trained workers where they are most needed those taken in 1940, when the approaching war with Germany was already apparent, deserve mention, which froze workers in their jobs, instituted penalties for sub-standard quality production, a seven day working week instead of the five day week which existed heretofore and an eight hour working day in most industries and created a labor reserve.

From 800,000 to 1,000,000 youths,

boys of from 14 to 17 years, were mobilized for industrial training. After training they will work for 4 years on state enterprises. The training, which is to take up to two years, is free and the youths are cared for by the state during their training period. This reserve is to be used by industry, not by agriculture. During their training the youths are exempt from military service.

In the opinion of some writers this measure was made necessary by a trend among the youth to go to the college grade schools in preference to the factory technical schools, and thus the industry suffered from the too high proportion of unskilled labor handling important machinery and from a disproportion between the college trained and intermediate technical personnel.

The law aimed at counteracting absenteeism in plants and flux of labor force was stated in the press to have benefited the industries of U. S. S. R. In the chemical industry this decree reduced the labor turnover within two months of its existence from 6.6 to 2.6 per cent and absenteeism from 5.4 to 3.2 per cent. The total increase of labor reserves available to the chemical industry through this decree was estimated to amount to from 15 to 30 per cent.

General Education

It cannot be overemphasized that the school system of the Soviet Union, just as the entire life of the Country, is undergoing a constant change.

I have a volume giving the most important laws and regulations pertaining to colleges in U. S. S. R. which were in force in 1940; almost none of these were promulgated earlier than in 1936; most of these laws were adopted in 1938 and later. Some of them are obsolete by now. The twofold purpose of education, however, remains the same, namely, devotion to the task of building the type of human society as outlined by the leaders of the country and to the place in it the student is to occupy upon graduation on one hand, and training him for performance of a specific function in this society on the other hand.

Russian articles on the conditions in the colleges consistently stress that the turning point in the evolution of these schools was the national convention of professors and administrative officers of these schools, which took place in May, 1938, and culminated in a meeting with Stalin in the Kremlin. At this meeting, V. M. Molotov, then the head of the government, while taking pride in the fact that the number of students in college grade schools of U. S. S. R. at that time already exceeded that receiving education in the universities and other college type schools of Italy, Germany, England and France combined, pointed out that the quantitative, and even more the qualitative objectives in Soviet higher education have by far not yet been reached and specified the nearest tasks.

It would be impossible to enumerate all the individual changes which took place in Soviet schools from the time when progress of students was judged without examinations and students coming from workers' or peasants' families were preferred for admission to schools for higher education over children of the middle class or aristocracy, to the present state, when no value is ascribed to the social origin of the student.

There are no reliable figures for literacy in Russia before the first world war. A generally used figure was 70 per cent illiterates. On the other hand,

P. Ignat'ev, Russian minister of education before the revolution, gave an estimated figure of literacy in Russia in 1916 as 56 per cent.

The 1939 census revealed a literary percentage of 81. The total enrollment in all types of schools was about 34 millions; of this number, 601,000 studied in the 525 college grade schools, which the country possessed. This is exclusive of correspondence courses and teachers' training institutes of lower than college standing. The plans called for an increase of the number of students in the third five-year period to 650,000 and the number of colleges to 600. There were in 1939 over a million people with completed college education in the country. This is being contrasted in the Soviet educational literature with the state of higher education in 1914, when Russia had only 91 college grade schools with a maximum of 125,000 students.

Special mention is deserved by the problem of women students. After the Revolution, the doors of all schools and professions were opened to women, and at the present time women are active in every field of industrial and social life of the Soviet Union. However, it is safe to assert that in those professions in which women were active also before the Revolution, such as medicine, their numbers are much greater than in others. There may be some women engaged in naval construction, for instance, but their number is certainly small; however, in 1939, 60 per cent of all physicians in U. S. S. R. were women; in some constituent republics the number of women physicians is still higher than this average, for instance among Bashkir physicians the number of women was stated to be 75 per cent.

Women direct research in many branches of chemistry and engineering. In some places they occupy administrative engineering positions of importance. Women amounted to 41 per cent of all students in colleges of U. S. S. R. in 1939; in the technical colleges they comprised 27 per cent. The greatest advance in this respect was made by the women of countries with a large percentage of Moslem population. Women of Uzbekistan, Azerbaidzhan and Turkmenia who did not dare to lift the veil from their face in the presence of men 25 years ago now study engineering, and in some cases teach engineering. Of all college educated engineers, 14.4 per cent were women in 1938. Of these, in the textile industry 32.8 per cent were women, in the food industry 31.1 per cent, but in coal mining only 8.7 per cent of the engineers were women, in oil production 9.3 per cent. The various branches of mechanical engineering had between 7.9 and 17.0 per cent women.

An education feature of recent years consisted in developing educational facilities in the various regions populated by national minorities. The number of students coming from these regions showed a consistent increase, and at the beginning of 1935 only 54.4 per cent of the university students were of Russian nationality, the others being Ukrainian, White Russian, Georgian, Armenian, etc. In the territories where languages other than Russian prevail schools were founded in which the native language and not Russian is the medium of education; Russian is only one of the more important subjects of instruction. Many secondary technical schools are also conducted in the native languages and some university courses in various subjects were

offered in these languages in recent years. There are over 100 languages and dialects spoken on the territory of U. S. S. R.; over 60 of these are recognized for official use.

From some territories very few students used to go to universities in pre-revolution days. This is frequently emphasized in the Soviet educational press and figures are given on the numbers of various types of schools existing today in these territories. I recall in this connection an anecdote from my personal experience at the University of Kiev. A student working with me in the laboratory of crystallography was taken by me and my friends for a Japanese until he greatly surprised us at the outbreak of the revolution in 1917 by saying that he was going home to teach. It appeared that he was a Kalmyk, and to his knowledge the third member of his tribe to go to a university.

Similarly to the schools, the Soviet press, as well as general and technical literature, is not limited to the Russian language alone, and there are many publications, especially those designed for minor engineering personnel, using the languages of the national minorities. It was alleged that the only limitation in compilation and publication of technical works in languages other than Russian consists in the number of qualified instructors and writers in these languages.

A general education facility created after the revolution is termed workers' faculties, a school for adults who did not have the benefits of secondary education. The students of these workers' faculties, or "Rabfak," as they are called, are maintained by the state while they study. They had an enrollment of 319,500 in 1932, after which the number began to drop, partly because the number of potential students of this type began to be exhausted.

At the outset of the revolution, the desire for education was so great among the youth of Russia and the fervor of local authorities to promote education and the standing of their communities in the Country so high that a very large number of institutions for higher learning sprang up without sufficient equipment or teaching personnel. Teachers from other cities were engaged for part time instruction. Professor V. N. Ipatieff relates a case of his being engaged to teach in a newly organized university where the local authorities even provided him with transportation, and paid some money in advance, although the pressure of administrative and scientific work made it impossible for him to leave Leningrad to lecture there.

It soon became evident that many colleges would have to be closed for lack of teaching personnel, which was actually undertaken by the Committee on Higher Education, who evaluated the merits of each case and decided thereupon.

The discrepancy between the number of teaching positions in colleges open and qualified instructors available reached 5,000 in the school year 1938–1939 and later dropped. Yet notices are prominently displayed in many Russian scientific and educational journals soliciting applications for teaching positions in colleges.

In 1939, the total number of professorships or chairs was close to 10,000, over half of them in the technical and agricultural colleges. The total teaching staff comprised 40,500 persons, against 5,800 in the universities and other college grade schools before the revolution. Only 46 per cent of the persons occupying these chairs in 1939

were permanently appointed. The others were temporarily in their positions, and many chairs remained vacant.

Reading the Russian technical literature, you find internationally known experts with 50 or more years behind them in their chosen fields still active and reporting research work. A. N. Bakh, the leading biochemist of the Soviet Union, N. D. Zelinskiĭ, head of the Organic Chemistry Institute and A. E. Favorskiĭ, editor of the *Journal of General Chemistry,* are all octogenarians and all active in their fields, as are many others. The scientists, regardless of their political philosophy, longed for a chance to contribute to the development of the natural resources of the Country. Many joined not only in the economic, but also in the political aims of Soviet education. The majority of the teaching personnel, however, is young, and for the most part educated under the Soviet regime.

Tuition in all schools of U. S. S. R. was free until recently and in 1939 89.7 per cent of students of all college grade schools received a state scholarship or stipend. A student of the first year was getting 130 rubles; second, 150 rubles; third and fourth, 175 rubles; fifth, 500 rubles. Aspirants, or post-graduate students in colleges and scientific research institutions carrying instruction duties were receiving 400 rubles per month shortly before the war. However, students who showed unsatisfactory progress in their work could suffer reduction of their stipends by 50 per cent. Dormitories, medical attention, cultural needs of students, etc., were also provided. However, in October, 1940, a decree was issued eliminating free tuition in secondary and college grade schools, as well as payment of state stipends to all students, except those whose study received the mark "excellent." The tuition was set at from 150 rubles a year in the higher grades of secondary schools to 500 rubles a year in art colleges. Correspondence school students pay half of the regular tuition. An idea of the value of these payments may be gained by comparing them with the salaries of the teaching personnel, which ranged in 1940 from 1500 rubles per month for the head of a department in a college with a doctor's degree to 225 rubles per month for a laboratory assistant with only elementary school education.

The absolute expenditures for maintaining the schools for higher education may not be very indicative, as there is no way of correlating them with the expenditure in dollars. However, it may be of interest to say that it doubled within the five years from 1934 to 1938, at which time it exceeded 2,000,000,000 rubles.

Generally, military service of students is deferred, according to a law of 1938, only for completion of their secondary school education, but not for college study. It is likely that the students of the last year before graduation, regardless of the branch of engineering they study, are deferred. Certain rulings issued in 1938 clearly point to a type of R. O. T. C. in the bigger Soviet colleges. For teachers' institutes and medical schools the program of military study was especially modified. For women students, courses in medical work are offered, as applied to wartime requirements.

Student activities in literature and politics have always been a characteristic feature of higher education in Russia. Some of these activities are preserved now in a greatly changed

form. Politically the Communist youth organization occupies the foreground. Sport organizations come into increasing prominence, with American sports being very popular. Chess is the favorite game.

Vocational Training

The apparent aim of the system of vocational education in the Soviet Union taken as a whole is to give a minimum of technical training to every employee of industry, from the common laborer up, and complaints are even voiced occasionally if in a certain industry a substantial number of workers is left without training. The scope of the program is indicated by the plan for the period 1938–1942, which called for training of over 9 million people for work in industry in different capacities. An American engineer who supervised in 1938 construction of a plant in the Soviet Union told me that in his estimation 50 per cent of the cost of the building went into the construction of social halls and class rooms.

Technical schools in U. S. S. R. aim at preparing engineers and also intermediate personnel. The first is done through schooling in college grade schools, the second involves study in secondary technical schools, called technicums, which occupy a position distinctly different from that of technical high schools in this country. They aim at preparation of assistant engineers. The secondary technical schools numbered 3,400 and had an enrollment of 700,000 in 1938; this enrollment was expected to reach 800,000 in 1942, at which time the number of technicums was to reach 3,500. For admission to a technicum 7 years preliminary schooling is required, as compared to 10 years' schooling necessary for admission to a college grade school. The course of instruction in a technicum is 4 years.

The role of a technicum graduate may be seen from the fact that some reliable estimates indicate a desirable ratio of from 3 to 4 people with this type of schooling per each engineer. However, in certain cases graduates of technicums with much practical experience get into responsible positions without having the title of an engineer.

A technicum graduate entering an engineering college is given no credit for his scholastic work in the technicum and has to take an entrance examination. However, if he is proficient enough he may take examinations in some of the courses given at the college without taking the course itself. In addition, his experience makes him ultimately a better engineer.

Factory schools perform an important function in training qualified workers. They showed an increase up to 1932, at which time they had 975,000 students in close to 4,000 institutions. Later, this type of school began to diminish in number. However, they were revived in a different form in October, 1940, when the decree was issued providing for creation of a labor reserve, as mentioned above.

During the first five-year plan the factory schools trained 450,000 workers. This number was tripled in the second five-year industrialization period, during which 1,400,000 qualified workers were graduated from these schools. According to the third five-year plan 1.7 millions were to be trained in these schools. Along with purely vocational training, they give a certain amount of general and political education, and whenever the work at a particular plant requires it, for

instance in the food industry, elementary rules of sanitation or information of similar value.

Industrial establishments in general served throughout the past 15 years as a training ground and it was estimated that in 1937 alone various schools and courses given at the plants graduated 3,000,000 out of 4,600,000 workers enrolled in them.

Correspondence courses leading to college degrees have been in existence in the Soviet Union for over 10 years in the field of social sciences, economics, law, agriculture, technology. Only in the field of medicine, is instruction by correspondence courses prohibited by law. About 1,000 engineers and about 3,000 teachers have been graduated by this system between 1935 and 1940.

The students taking correspondence courses have to present themselves in person for practical laboratory and shop work for about a month a year, for which time they get leave from the plants where they are employed.

The system is sometimes criticized on the basis that there is lack of organization of its program and the difficulties connected with this method requiring extensive correspondence and occasional interviews with students who fall below the required level of progress.

In the rural districts a form of technical instruction has been recently made available consisting in Kolkhoz laboratories which are designed in the first place to aid the work of the farmer and improve the crops, but at the same time they disseminate much simple and rudimentary information on agriculture, soil chemistry and other subjects. There were 11,500 of these simple laboratories in the Ukraine in 1934, 125 in Turkmenia and a substantial increase of them was planned.

There were at least 4 systematic courses of study in the Ukraine designed to prepare workers for these Kolkhoz laboratories; the experience of these laboratory workers rates much higher than their education, as a rule.

The Engineering College

Admission to a university or technical college in the Soviet Union, the course of study and graduation regulations are largely governed by the Committee in Charge of Schools of Higher Education with headquarters in Moscow. In addition to graduation from a secondary school, *i.e.*, a total of 10 years' preliminary schooling, the prerequisites for admission include also a competitive examination, and a number of students fail to pass this examination each year. Results of the examinations are published in the most important newspapers. Candidates graduated from the secondary schools with excellent marks may be excused from the entrance examinations.

The average age of a first year student at the present time is 19–20 years. The course of study of the engineering colleges is 5 years, with slight differences depending upon the branch of engineering.

Concerning the curriculum, a student in a technical college takes a prescribed set of courses in which he has no option and has to pass a series of examinations in these courses. A student can pass to a higher class only once a year on the basis of these examinations, the results of which are graded by a four-mark system, the marks being excellent, good, fair and unsatisfactory. The programs of study comprise practically the same basic subjects as given in the engineering schools in other countries with the following exceptions.

In the first place, the present day engineering college in U. S. S. R. aims to give a higher extent of specialization. Just what extent of specialization is to be aimed at is a matter of lively discussion in the educational circles. A number of small departments with only ten or fifteen students have been closed down for reasons of economy and lack of teaching personnel. Some authorities also defend the principle of what is termed "polytechnism" as against too narrow specialization without sufficient grounding in general engineering subjects. There is a general agreement, however, that the young graduate is to be able to adapt himself to a specific industry within as short as possible a span of time. In this connection lack of unity in the programs of instruction has been pointed out, allegedly responsible for insufficient initiative on the part of some recently graduated engineers or candidates for graduation. The urgency of centering the study of general subjects, such as mechanics, strength of materials, etc., taught in the first three years, around the special branch of engineering in question was stressed. However, the majority of instructors of engineering seem to go cautiously about changing curricula, and the 1938 convention devoted to methods of teaching chemical engineering exemplifies this point.

The Russian language was not a subject of instruction in engineering colleges prior to 1938 when it was introduced in the first two years of all colleges located in the territories populated by national minorities, such as Georgia, Kazakhstan, etc. The required time is taken from that allotted to instruction in foreign languages.

A program of study in social and economic sciences including history and philosophy of the Communist Party is included in the scholastic work of all colleges and also in the work of the post-graduate students.

One foreign language is prescribed, depending upon the branch of engineering; for instance, English for petroleum engineers, German for mechanical engineers. This language is studied throughout the five-year course and the graduating engineer is expected to be able to read the technical literature in the language concerned.

The teaching staff is required to possess a doctor's degree, similarly to university professors. Most professors teaching general subjects, such as mathematics, physics, etc., either have such degrees by now or work for them. This is stimulated not only by official rulings, but also by a differential in salaries and by a law according to which courses in a number of subjects should be given by professors holding doctor's degrees, those without such degrees being considered as holding the position temporarily and subject to displacement by a Sc.D. or Ph.D. whenever one becomes available and recommended by the authorities in Moscow.

The older institutions which have been in existence for a longer period of time have, as a rule, a higher percentage of instructors with advanced degrees and in some cases also better equipment. However, no money is spared for buildings and equipment when a new school is being founded by government authorities.

Examinations in Soviet colleges are both written and oral. In many cases the old system is preserved according to which the course is divided into numbered portions, and the student is obliged to draw a ticket with a number and is accordingly examined in the

portion of the course the number of which appears on his ticket. The form of examination depends upon the local faculty and not central authorities.

Many students are employed by various industries during the summer. However, they get no credit at the college for this work, even if it falls within the branch of engineering they study. The required plant practice for which credit is given comprises approximately 6 months' work. This period of time is strictly regulated and distributed among the various departments of a plant in which the student is working. It is usually done in two-month periods at a time within the last two years of college work, and is accompanied by reports of the students, supplemented by brief reports or opinions of the engineers who supervise this work at the plants. Groups of 3 to 6 students usually work in squads in the plant.

Research work, plant or machine designs are required for graduation, and, as a rule, problems are treated in these researches constituting a part of an actual problem faced by the given industry.

The teaching personnel is also engaged in research of its own, the scope of which is considerably larger. The contributions to industry from this source, however, are certainly much smaller than those of the research institutes the exclusive purpose of which is to serve the heavy industry.

The intention of creating a unified plan of all research done in the technical colleges throughout the U. S. S. R. was indicated in the press; the idea is to ultimately integrate the research and systematically check on its progress. Full credit for the research and any inventions resulting therefrom is given. In passing, it may be remarked that invention activities of engineers and workers are solicited and encouraged by all means of propaganda and that the Soviet patents give certain material remuneration and prestige.

An interesting example of the applicability of some research is the case of the Institute of Engineers of Public Nutrition, where a diet was developed for the 1936 meteorological expedition to the far north headed by I. D. Papanin, with special consideration of the effect of low temperatures on the foodstuffs used and their vitamin contents. The success of this research resulted in its repetition for a number of other expeditions to the far north, including the expedition to this country via the north pole.

The graduates of technicums, as well as college grade technical schools, are free to select a job in their specialty, the school often acting as intermediary between the state controlled industry and the individual.

There are always more positions open than graduates available, and the 155,000 engineers and agricultural specialists who were trained in the over 200 engineering and agricultural schools during the third five-year plan were certain to fall short of the need. Similarly, 50,000 college graduate chemists were serving the chemical industry of U. S. S. R. in 1939, instead of the 1,000 chemists employed in this industry in 1913, and there were many vacant positions for chemists.

A post-graduate student working for an advanced degree either in a school or research institute serving industry is called an aspirant. The number of aspirants studying in the 265 colleges accredited by the central authorities

for post-graduate study was 5,635 on January 1, 1938; this was to be raised to 10,000 in the following years.

An aspirant is obliged within 3 years to present a dissertation embodying research done under a qualified supervisor. Not more than 5 aspirants may work under a single supervisor. However, some aspirants are permitted to work in absentia, in which case they are to use their stipulated 30-day leave from the place of employment for examinations, experimental work or dissertation. According to the law, resident aspirants are to have only instruction duties. Insufficiency of teaching personnel is responsible for the fact that in some cases instructor aspirants are given other duties, including administrative duties in college, which correspondingly prolongs their training period.

There are two degrees which can be earned by advance study, *i.e.* candidate of science, corresponding to our master's degree, and Sc.D. The list of candidates for doctor's degrees in all colleges throughout the country is published in advance with the date at which their dissertations are going to be presented. The candidates for degrees present their dissertations in public sessions with many non-faculty members participating in the discussion. Every advanced degree has to be confirmed by a special committee attached to the Committee on Higher Education, which also confers the title of professor, docent (assistant professor) or senior scientific worker. The title of junior scientific worker, roughly equivalent to our instructor, is given by the director of the college or research institute.

It should be stated, however, that doctors' degrees are given from time to time honoris causa by the accredited institutions and the Academy of Sciences and that every man elected to active membership of the Academy of Sciences becomes a Sc.D. eo ipso. Furthermore, scientists of outstanding achievements and professors of especial merit are adjudged this degree without presentation of a formal dissertation.

Just as in most other European countries, the academic degree or title is a much valued possession, and authors frequently attach the titles "Academician," "professor," "engineer," etc. to their names in signing their publications.

Most engineers, and also many students of technical colleges, are members of the special engineering societies, the membership of which grew rapidly after the revolution, as well as the number of the societies themselves. However, membership in the engineering societies is not compulsory. From certain literature accounts of the activities of these societies, it is seen that they are active in promoting research in their industries and have social functions of great importance.

Similarly to other fields of educational activity, preparation of textbooks is in a large measure centralized in U. S. S. R. The All-Union Committee on Higher Education is active in promoting that activity, providing, if necessary, special leave for the authors to give them time to write the textbook contracted for. The publication activity in this field is lagging behind the schedules, in some cases by 30 per cent and more.

A large scale translation program is being carried out by the Soviet publishing houses. I know of cases of voluminous engineering reference books, translations of which appeared in the Russian language within not more than one year after their publication in this

country. Complaints are sometimes voiced against the quality of original and translated texts. On the other hand, a general improvement is apparent and many examples of excellent work were noticed in the recent past.

In the observation of non-Russian engineers who had a chance to frequently come in contact with young Russian engineers they were, for the most part, excellently grounded in mathematics, physics, chemistry, drafting, etc. In their practical work they were hampered by the fact that they had studied on examples of processes and equipment which were lagging behind those employed in this country for similar purposes by from 5 to 10 years, but they were always eager to learn. Another feature in the training of the young engineer is perhaps peculiar to Soviet industry. Savings in materials are aimed at at the expense of labor and engineering time. Excessive detail and embellishment is practiced in some cases. On visiting an oil refinery an American engineer saw a series of hot oil pumps. One of these pumps, Soviet made, was executed with so much care of its appearance and so much handwork that the American suggested that it be placed in a museum.

A new branch of engineering was created by the planning of the entire economic life of U. S. S. R., and accordingly at least one special institute exists, known as the Molotov Planning Academy, founded in 1928. This field is distinguished from economists' activities proper.

The distribution of economists in industry is an interesting point. The graduates in this field are assigned to work in the various branches of industry. For instance, the oil industry requires 400–500 economists every year, the chemical industry 700–800.

The work of these economists consists mainly in planning and checking up on the fulfillment of the individual plans. In addition, they manage problems of supply, organization and planning of production, efficiency of labor, etc.

Along with adaptation of non-Russion methods of production to Russian conditions, development of new methods and even new industries takes place in the Soviet Union. This brings into being new branches of engineering. Underground gasification of coal was separated into an independent industry in 1939. The results of the experimental work in this field are being collected. A book was published in 1941 on the engineering of this industry and engineers are being trained to further this development.

The synthetic rubber industry of U. S. S. R. was developed since 1928 and required an increasing number of specially trained chemical engineers as it was able to substitute larger amounts of natural rubber.

An industry in the initial state of development in U. S. S. R. is manufacture of non-petroleum fuels for internal combustion engines to be used in Siberia and other territories which have no oil fields of their own. These fuels include producer gas, coke oven gases, coal, lignite, etc., and large scale use of some of them has been reported. Employment of wood chips as fuel for at least 100,000 engines was planned for 1942. Training of specialists for designing and servicing the modified engines suitable for use of these gasoline substitutes has already been discussed in the Russian engineering literature.

Conclusions

The above remarks, which are based on figures published in Russian journals and on objective observations, have nothing to do with defense of a political policy. They leave entirely out of the discussion whether or not the same results could have been achieved by different means, but an analysis of the available information certainly supports the claim to great achievements having been made and educational facilities greatly expanded for educating an engineer who is striving to use his training to the best of his abilities, not only for personal, but also for social reasons, whether these social reasons consist in ultimate triumph of a party ideology or in satisfying his national pride.

It may be thought that after this war, when the economic development of the Soviet Union will be free of the purely military aspect of it, the political side of the education of the Soviet engineer will undergo a change. The reconstruction of the Soviet Union after the war may be regarded as the only great immediate objective of the entire economic and political life of the Country as soon as the war is won. This reconstruction is certain to bring the Soviet engineer closer to the American engineer than ever in history heretofore. The prerequisites for this approach were always present; the eyes of the Soviet planners and engineers were always turned to the American methods of mass production and students of engineering are shown examples of adaptation of these methods. The Lend-Lease operations, supplying a large variety of different products, bring this process a step further in that the handling and use of these products becomes more familiar to Soviet technicians.

When you consider the enormous task of rebuilding the devastated regions of western Russia and Ukraine, and, on the other hand, that the American engineer may be destined to participate in that work of reconstruction in a large measure, the conclusion is apparent that there is an added problem of importance for the engineering college in this country today, among all other wartime problems. That problem consists in a more detailed investigation of the scene on which this reconstruction role is to be played, so that the American engineer may be properly equipped to translate some of the industrial experience of our country into Soviet practice in the initial period and to continue the contact in the more distant future, which may be greatly beneficial for both sides, from both an engineering and an economic point of view.

Work of the Armed Forces Institute*

By COLONEL FRANCIS T. SPAULDING

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The United States Armed Forces Institute can be properly described as a correspondence school. Like civilian correspondence schools, it writes to its students and they write to it; it seldom meets any of its students face to face. Also like civilian correspondence schools, its purpose is to give men and women—especially young men and women—a chance to learn in their spare time. The Armed Forces Institute, however, differs from the usual civilian correspondence school in so many other respects than these, that to think of it merely as a correspondence school is to miss its real significance, which lies not alone in what it is, but in how it started and in what it may become.

Six months before Pearl Harbor, plans were being made in the War Department to provide educational opportunities for young men brought into the Army under the Selective Service Act, so that those young men might have a chance to supplement their military training with other kinds of training which would be of advantage to them when they returned to civilian life. The plans were almost ready to put into effect in December, 1941. Pearl Harbor caused a change in plans. It stopped them for a few weeks; then it pushed them forward with new urgency, but in a different direction. Whereas the first intention had been to set up an educational program pointed chiefly toward the return of a majority of the Army personnel to civilian jobs or civilian schooling, the revised plans called for an educational program which would supplement and reinforce the Army's basic program of training for war.

It was in keeping with these revised plans that the Army Institute was established in Madison, Wisconsin, on April 1, 1942. The idea of an Army Institute was not new: the Marine Corps had had such an Institute for twenty years, and the Air Corps had established an Institute of its own in 1940. The Army Institute operated on a different basis from either of these, however, in that, besides offering correspondence courses itself, it arranged with the extension divisions of universities all over the United States to make available to men in service, with the aid of partial fees from the Government, correspondence courses from their own regular offerings which might be of particular interest to military personnel. In providing these courses the Army Institute was not intended to serve as the sole agency for off-duty education in the Army. Its place was that of an important adjunct to the programs of class instruction which had already been set up in many camps, and which now enroll thousands

* Presented at the 50th Anniversary Meeting, S.P.E.E., Chicago, Ill., June 18–20, 1943.

of students both in the United States and overseas.

Since its establishment, the value of the Institute has been widely demonstrated in its increasing enrollments. Its early growth was slow. In the late summer of 1942, however, the publication and distribution of its catalogue began to bring in new enrollments, first by hundreds, then by thousands, every month. In recent months the numbers of new students being continually added have climbed to approximately 1,500 each week, and have held steadily at that figure. Arrangements made at the request of the Navy Department some six months ago resulted in opening the enrollments to men and women from all branches of the armed services—Army, Navy, Marine Corps, WAACs, WAVES, and SPARS; and the present name of the Institute (the Armed Forces Institute) was substituted for the original name (the Army Institute) to signify its broader service. The constantly growing numbers of students from all the services have been a reflection both of the widespread interest of American young men and women in keeping on learning and of the fact that the chance to learn is for many of these young men and women in service as important a factor in their morale as are the radio or movies or organized athletics.

The value of the Institute has been demonstrated also in the kinds of courses chosen by its students. The largest number of enrollments in any single subject has been in mathematics —arithmetic, algebra, geometry, trigonometry. Among groups of subjects, the technical subjects—motor mechanics, radio, electricity, machine shop work—are far in the lead. The next most frequently chosen group has been that of the clerical subjects—typewriting, shorthand, bookkeeping, business English. Enrollments in the more general subjects of the high school and college curriculum have apparently come chiefly from students engaged in somewhat unusual military jobs, and accordingly have trailed behind the others. The pattern of enrollments as a whole has paralleled the Army's needs for fundamental education in those subjects which chiefly underlie specialized military training, and thus has given evidence of the interest of the men and women in service in preparing themselves to do the best possible military jobs.

With the growth in the Institute's enrollment, however, has come a paradoxical result: the larger the Institute has become, the less practicable its correspondence-study program has grown. The explanation of the paradox is straightforward enough. New enrollments have brought a constantly increasing proportion of students from overseas. At the end of last February the students at camps in the United States and the students overseas were about evenly divided. At the present time, the overseas students outnumber the students from within the continental United States by almost two to one, in spite of the fact that both groups have been growing. And with students overseas, correspondence back and forth to Madison, Wisconsin, will not work as a basis for regular instruction. In fact, for many students overseas, correspondence with any single center will not work effectively, until our troops stop moving about and deliveries of mail become easier and more frequent.

A partial answer to the problem obviously lies in the establishment of overseas branches of the Institute. One such branch, operating in collabo-

ration with the University of Hawaii, has already been set up near Honolulu. Using the air mail service from Hawaii, this branch serves not merely the Army and Navy forces in the Hawaiian Islands, but scattered Army and Navy units all through the South Pacific. Four more branches have been asked for by the headquarters of various overseas commands. Others will undoubtedly be needed. The Institute at Madison has already begun to multiply itself, in other words, and will have to keep on doing so.

But beyond what can be accomplished by multiplication, there are still needs to be met which instruction by correspondence cannot adequately meet. For men whom even the branches of the Institute cannot reach, materials are being prepared which make possible almost completely independent learning. Through the use of these self-teaching materials, the Institute is attempting to make up not merely for the lack of regular mail service, but for the absence of qualified teachers, or class-groups, or the usual teaching equipment, among many of our men overseas who nevertheless have the time and the inclination to go on learning.

The self-teaching materials represent a sufficiently radical departure from ordinary textbooks or correspondence course outlines to deserve brief comment. They have been developed for the most part by a special civilian staff recruited for the purpose. This staff has searched for the best available textbook in a given subject, and then, with the coöperation of the author and editor of the book, has undertaken to revise it in such a way as to put into print the directions, explanations, examples and tests of mastery which a good teacher would supply if he were using the book as a basis for his teaching. Sometimes this has meant additions to the text. More often it has also required the preparation of a workbook to accompany and supplement the text.

For various subjects the Editorial Staff has found that a teacher could not be supplied in print alone, because hearing the teacher, or seeing him, was necessary for effective learning. A number of the self-teaching courses, therefore, make use of records as well as of printed materials. The records for the courses in foreign languages are particularly noteworthy; they supply not just one teacher, but two—one who speaks "American," the other a native speaker of the language being taught; and in this respect they go beyond what even an exceptionally good American teacher could provide in person for the students in his classes. Though no courses making use of films as a substitute for a teacher have yet been developed, films may still be used if print and records will not suffice.

Perhaps it should be said that neither print nor records nor a moving picture can be expected adequately to take the place of a skillful teacher. But experience has already indicated that self-teaching materials can do at least as good a job of teaching in many different subjects as can a mediocre teacher; and they can obviously do a better job than can no teacher at all. The Armed Forces Institute is now making use of such materials in about a dozen separate courses. The staff which is responsible for the preparation of the materials expects to have completed, by next November, self-teaching materials for all the courses necessary for a basic educational program extending from grade 5 of the elementary school through the last year of high school, and to have made

a substantial beginning on self-teaching materials for the courses which represent the general-education program for the first two years of college. The materials already developed have demonstrated their value not merely for students working by themselves, but for many of the class-groups organized for off-duty study in the camps. With the completion of the full list of courses, both individual students and class-groups will have available not the best conceivable educational program, perhaps, but at least the best practicable program.

The provision of self-teaching materials represents an important respect in which the Institute has gone beyond the role of a correspondence school. It has stepped out of that role in another respect as well. Being concerned not only with what happens to its students educationally while they are in the service, but with what will happen to them when they get back, it is in process of setting itself up as a clearing-house through which schools and colleges and employers can get dependable information on the educational achievement of men and women in service.

The task which the Institute has undertaken in this area has grown out of a series of recommendations made about a year ago by a special committee of the American Council on Education. The committee in question was asked to propose appropriate ways of recognizing the educational achievement of men and women in service, whether that achievement took place as a result of Armed Forces Institute courses, or through off-duty class instruction, or through special military training, or as a consequence of less formal learning and maturing. The committee's recommendations, somewhat revised and elaborated on by other groups that have considered them, were recently published in a special American Council bulletin entitled "Sound Educational Credit for Military Experience." Briefly summarized, the recommendations are threefold: that the kind of blanket credit for military service offered by many schools and colleges in the last war be avoided; that the Carnegie-unit system of crediting educational achievement in the service be recognized as in most instances both impractical and invalid; and that in place of the Carnegie-unit system the armed forces be asked to supply dependable data as to students' educational growth in service, on the basis of which the schools and colleges in which those students may be seeking academic credit either now or after the war may be able to judge their educational maturity and their achievement in specialized fields of study.

The endorsement of these recommendations by all the major accrediting associations and by more than 500 individual educational institutions has given the Armed Forces Institute ample justification for providing the machinery by which the recommendations may be put into effect. Accordingly, the Institute has set up a staff of specialists in test construction, who are charged with supplying the necessary examinations. The Examinations Staff has already completed or done preliminary work on some 60 examinations in separate courses or subject-matter fields. By early next fall it will have finished the standardization of two test-batteries, one for high school students and the other for applicants for college credit, which will provide the basis for a fair and objective measure of students' general educational maturity. Through the use of these two kinds of

measures the Institute will shortly be in a position to give the help that has been requested by schools and colleges, toward making a sound appraisal of educational work done in the service.

In its correspondence-study program and in its provision of self-teaching materials, the Armed Forces Institute represents what may perhaps be called an accomplished fact, even though the fact is still changing in dimensions. In its service as a clearing-house for educational credit there is reason to expect that the Institute will soon represent a similarly accomplished fact. These facts are an answer to present needs, and hence are of considerable importance. Of even more importance are likely to be the answers which the Institute will almost certainly have to supply to future needs.

The day of any large-scale armistice, whenever it comes, will surely mark as abrupt a change in purpose on the part of the Army educational program as the change that took place on December 7, 1941. From armistice-day on, the focus of the educational program will be the preparation of most of the men and women now in service for their return to civilian life. They will need a re-orientation to civilian life, just as they have needed an orientation to war. They will need full and accurate information about the provisions that are being made for them by the Government, about the kinds of jobs that will be open to them, about conditions in their homes and their communities. Thousands of them will need training, or retraining, for jobs that will enable them to make a living as civilians.

Toward all these services the Armed Forces Institute will almost inevitably have a substantial contribution to make. Its present organization, personnel, and methods of operation have been planned with this contribution in view. To the end that it may play a full and effective part in the post-armistice period, certain major extensions of its work are already being provided for. Recommendations are being sought from appropriate educational authorities for broadening its program of courses, particularly at the college and university level. Arrangements are being made for supplying teaching materials on a wider scale, not just to individual students, but to the class groups that have been organized, and will continue to be organized, in increasing numbers. Plans are being made for the systematic educational and vocational guidance of students in the light of information about the students themselves and about their probable chances in the post-war world.

Through these various channels it is hoped that the Armed Forces Institute may become a major factor in helping men and women in the services to make the difficult transition from war to peace. The Institute cannot do the whole educational job that will be required; much of that job will necessarily fall on the schools and colleges which must be ready to carry on with the education of the returning soldiers and sailors. But it is hoped that the Institute may provide an educational foundation on which the schools and colleges can build effectively, and that they, in their turn, *will* build on that foundation.

Just as the Armed Forces Institute is more than a correspondence school, it is more than an expedient device for preparing young men and women for war. It is, in essence, a working symbol of the determination on the part of both the Army and the Navy that the young men and women who are wear-

ing the uniform of the United States shall get as much educational benefit as possible out of their service as soldiers or sailors or marines.

Discussion

CHAIRMAN WOODS: Are there questions from the floor? Some of these developments are indeed interesting. I wonder if you would indicate the extent to which the American Council on Education may have been coöperating in this matter of future credit.

COLONEL SPAULDING: Yes. We have worked very closely from the start of this program with the American Council on Education—or perhaps I should say as far as arrangements for credit are concerned that the American Council on Education has worked with us. The program for credit which the Armed Forces Institute is following was recommended to the Army by a special committee of the American Council, called together to consider what arrangements should be made for educational credits for work done by men in service. The Armed Forces Institute is following as closely as possible to recommendations made by this American Council committee.

The American Council on Education has been very helpful in connection with various phases of the off-duty educational program. It has recently established a joint committee of its own organization and of the Association of American Colleges, a committee of which Dean McConnell of the University of Minnesota is chairman, to recommend the program of general education which the Armed Forces Institute should make available to men and women in service, covering the school years from grade 11 through grade 14 inclusive. This committee's report is to be completed by the middle of July. Its preliminary reports contain proposals not merely for the broad outlines of a program of general education but for the types of teaching materials and of subject-matter content which the committee feels would furnish an effective basis for young men in service who, coming back from the Army or the Navy, are to go on with their general education after the war. We have already begun to put into effect some of the more specific recommendations of this committee. That is to say, we are preparing self-teaching materials at the level with which the committee is concerned, growing out of the committee's recommendations.

In all these matters we have been working as closely as possible not merely with the American Council on Education and the Association of American Colleges but with other organizations—I need mention perhaps only the National Association of Secondary School Principals, which has its own committee on accreditation, and the National University Extension Association. We have been working with these groups with the conviction that, while the education of young men and young women for war is the immediate concern of the Army and the Navy and is an area in which the Army and the Navy must have the deciding voice, the education of young men and young women for peace is not the primary business of military authorities. The cue as to the direction and the content of an educational program designed to prepare young men and women for effective participation in the world after the war can best be sought in the agencies which can speak with most wisdom and with greatest experience on that subject—

namely, the organizations of civilian educators and civilian educational institutions.

QUESTION: What relation exists between the Armed Forces Institute and the Veterans' Bureau with reference to possible training of men now leaving the services and who are to leave?

COLONEL SPAULDING: At the present time there is no formal relationship. The difficulty of establishing a formal relationship thus far has resulted from the designation of the funds appropriated by Congress for the Army education program. Under the provisions of the appropriation act, our materials cannot be used except for members of the Armed Forces. Until recently the Veterans' Administration had no funds which it could use for the purpose of supplying instructional material for its people. Since March 24 the Veterans' Administration has been assured of such funds. It is to be hoped that eventually the men who are transferred from the Army to the Veterans' Administration will be able to go on with the same kind of program that they have had in service through the Armed Forces Institute. We have already had some preliminary conferences with the Veterans' Administration looking toward a coördination of the educational services provided for men before and after their discharge, and we expect sooner or later there will be a definite scheme of coördination worked out.

A similar problem exists, I may say, with respect to men in the Maritime Service. Representatives of the Maritime Service have asked for extension of the program of the Armed Forces Institute to the Maritime Service. There again we are limited by the language of the appropriation act. The members of the Maritime Service are civilians, and we cannot supply civilians.

CHAIRMAN WOODS: Has any special attention been given to the question of engineering credit?

COLONEL SPAULDING: Not as such. Representatives of institutions offering engineering education have been included in a number of the committees which the American Council on Education has set up to consider this question of credit. I may say that we have not gone as far yet as we must go with respect to the scheme of providing for credit in specialized fields of professional, semi-professional and technical education. Our attention thus far has been devoted to the working out of schemes for the provision of credit for general education. We have been assured, however—and I hope the assurance is sound—that the same basic scheme as that recommended by the American Council will be a scheme thoroughly applicable to the more specialized fields, as, for example, of medicine or dentistry, the field of law, and the fields of the various engineering and technical subjects; and we are working in the direction of a more explicit definition of the standards about which the specialized institutions want to be informed in order that they may properly take into account the men's work in service.

May I put in here a point which I did not mention earlier, with which you are no doubt familiar, but which perhaps cannot be emphasized too much. The Armed Forces Institute is not setting itself up as an accrediting organization nor does it ask to be accredited. We do not want it to be accredited. We would rather have the work that it does judged by what its students have learned. Consequently,

all we are intending to do is to tell you—to tell the educational institutions—what the students have learned. The Armed Forces Institute does not intend to say how much credit the men's educational achievement in service should carry in terms of points towards graduation. It intends to leave that question where it properly belongs, with the institutions that are receiving these men back for continued education, or are evaluating the education that they have received as entitling them to diplomas or awards of various sorts.

The Institute has been asked to let the institutions know how the achievement that these men make is usually accredited. It will go that far. It will tell you where these men ordinarily are regarded as standing in other institutions, but it will not say what any individual institution should do about any individual student. Its concern is only that in the award of credit, fair recognition shall be given to the actual facts of the case, those facts being what these young fellows have learned, and we know that they are learning a lot. That we would like to have you recognize; but how you recognize it is a matter which should be determined by the institutions that do the recognizing, and not by an outside authority.

Relationships Between War Manpower Commission and the Engineering Colleges*

By W. W. CHARTERS

Director, Bureau of Training
War Manpower Commission

My acquaintance with the Society for the Promotion of Engineering Education is rather extended. I am sure that I belonged to it before a good many of the young people here who are now members. With Professor Bishop and other people at the University of Pittsburgh and Carnegie Institute of Technology, I was once a member in good standing. Why I ceased to be a member in good standing is another question; but it does not reflect in any way upon the Society for the Promotion of Engineering Education. I have watched your publications steadily through the years and know well the fine contribution that has been made by this Society to engineering education. Therefore, I speak this morning as though I were among friends.

I shall first speak for a very few minutes about the relationship of the engineering colleges and engineering education to the War Manpower Commission. Then, since this is a Society that is particularly committed to the problems of engineering education, I shall make a few observations concerning what seems to me to be the concepts in engineering education that are being emphasized at the present time.

The War Manpower Commission has made wide use of the engineering schools—and by the War Manpower Commission I mean largely the government's activities over which the War Manpower Commission has, in an executive order, the responsibility for "the efficient utilization of the facilities of institutions of higher education."

First of all, in the program of the Army and the Navy which is now being carried through (not as swiftly as might be hoped), the responsibility of the War Manpower Commission is to assist in the selection of those schools with which contracts are made. The actual curriculum itself was set up in the executive order as the responsibility of the Army, the Navy, the American Council on Education and the Office of Education. The War Manpower Commission is not responsible for the content of the curriculum. However, under the phrase "the efficient utilization of the schools of engineering" the War Manpower Commission does have authority to help to have the colleges efficiently utilized.

The Army and the Navy are taking approximately 75 per cent of the training stations in the engineering schools.

* Presented at the Fiftieth Anniversary Meeting, S. P. E. E., Chicago, Ill., June 18–20, 1943.

There is a 25 per cent gap and the problem of what should be done with these facilities is under operational consideration at the present time. I am sorry that I can not at the present time make a statement about what specifically will be done, but we have been working for two months and things are about ready to come to a conclusion.

We have also the matter of deferments which expires on July 1st. It is my personal expectation—and I under-line the word "personal"—that deferments will be continued.

In addition to those uses of the colleges of engineering we have, of course, the ESMWT. I pause here to express my most hearty appreciation of the fine work that has been done by the men of the colleges of engineering. They have performed a generous service, the more noteworthy because many have not been paid for it. They have done it in addition to their regular load. I have met with the representatives; I have visited some of the centers; and I repeat the fact that it is a grand job that is being done by the professors. It would be a dereliction of duty on my part to fail to make this statement in official fashion.

Those are some of the ways in which the engineering schools and the War Manpower Commission are related.

Because of my interest in education and the curriculum during the past several years, and particularly because of my interest in engineering education, I thought you might enjoy—as a body interested primarily in education—a brief analysis of some of the concepts which are now being given a workout in the present situation involving the war and the pressures that come because of it.

First of all I say, what every one knows, that the curricula of engineering schools are functional in the sense that their purpose is to turn out good engineers. There are, however, two methods that have been recognized in accomplishing this end. One is to teach the fundamentals of engineering to all students and then have them make applications to practical life, with the belief that the principles so taught will give them a basis of information which will help them to meet engineering problems as they emerge from day to day. The other principle is that curricula may be built from a consideration of how things function in practice and then assemble from the science of engineering and the fundamental sciences those facts and principles which will help practice. One is called an organized curriculum based on fundamentals, and the other a selective curriculum based upon the needs of engineers in practice.

The arguments that are used on the two sides are quite well known. With regard to the organization of the fundamentals, the position is held that if one learns the principles then as problems change he can use them in solving current problems. The arguments that are used against it are these. It is extremely difficult to know what the fundamentals of engineering are because of the fact that engineering is growing so rapidly and covers so many fields.

A second criticism against the teaching of fundamentals first and by themselves is that there is then a tendency for them to be taught in a vacuum. The students do not yet see their applications and consequently they do not get their full import nor do they learn them as well as they would if they could see applications and go from the problem to the fundamental as a

method of solution of the problem. On the other hand, the objection to the functional approach is that there is a danger of learning skills and methods without the fundamentals—learning the *how* without understanding the *why*.

How to get those two points of view united, to be certain on one hand that the fundamentals will be taught, and on the other hand that the student will have learned the methods of application and will have seen the use for the principles and fundamentals being taught is the problem that faces engineering education today. I am not taking a position on either side; I am merely describing these two approaches.

With that as a background I should like to mention five concepts that, as I said a moment ago, are getting a workout where engineering practices, methods and techniques and principles are being taught in those centers where there is a need for furthering the war effort in the plants, in the schools, in the classrooms in ESMWT.

The first point is this. I see an emphasis upon what may be called specificity—the teaching of specific skills rather than general patterns and backgrounds. I may illustrate this graphically in connection with vocational training in the high schools. In times of peace the objectives of vocational education are three-fold. First, instruction is designed to give the boys a good general education—to teach them how to be healthy, to know the tools of communication, to be informed on social and political issues. Second, vocational courses are designed to give the student a good broad background of understanding of industry in the culture of the nation. Third, students are taught a broad variety of skills in some one occupation. Stress is laid upon acquaintance with the skills rather than upon perfection of performance.

However, in war time in the nation today we see a radical shift of emphasis. War courses are not concerned with training in general education, nor with the backgrounds of industry. The objective is narrow and specific—to make the trainee highly competent in a specific skill.

At first I was startled by this shift but at no time have I been opposed to it as a war emergency measure. We are compelled to get the workers on the machines as rapidly as possible.

The same principle holds with regard to ESMWT. Those of you who are teaching the courses know that the fundamental method of selecting the content of a course is to find out after the students are assembled what it is necessary for them to know. The curriculum is then developed to teach those specific things.

In those directions, and many others which I might mention, the idea of the specific function of the courses to be taught is getting a workout. The point to be made is this: we are discovering quite a few things about the techniques that might be used in developing greater specificity because we have been thrown up against the problem. I have myself seen methods of curriculum construction that have added to my knowledge of useful techniques.

In talking to a director of an ESMWT program upon this subject, he said: "Well, of course, what we are teaching is really not college work."

I said, "Well, if it is high school work, the vocational training people ought to do it then, oughtn't they?"

He said, "That isn't exactly what I mean."

What he meant was this, as I interpreted it. The organization of the material in ESMWT courses, its nature and its comprehensiveness were not similar to that which was being taught in college. He recognized these courses as not being the same as a conventional college course. He carried in his thinking the idea that, while engineering is a fundamental field where teachers pay attention to what is needed in the field, the reorganization of the ESMWT courses is carried to an extent and perhaps with an incompleteness that makes them radically different from the courses that are actually taught for college credit in the schools of engineering.

Again I am taking no position with regard to specificity. I am merely indicating that applications of principles to practice of engineering is one of the major and final outcomes of engineering education. It will be worth while for a group of educators such as the S. P. E. E. to look into this problem to see what is being done now in ESMWT courses, to see whether there are not some techniques and points of view there that might very well be woven into the curriculum for engineers when the war is over.

A second concept which is now being worked upon is intensity of work. This is seen in two or three directions. In the first place we have what is known as the accelerated curriculum, which means that more work is being done in a calendar year. The accelerated curriculum is of two types. One is where the students go to school more months per year—go to school in the summer, for instance; the other is where they take more and harder work in a given time.

So far as it is generally understood for purposes of legislation the first idea is the one that is accepted: to get through more quickly because you stay in school longer. The second one, however, is also being carried through in cases in which material is streamlined and in which, by deletion of unessential materials, more of what seems to be important work can be carried through. There is perhaps less padding in engineering than in the colleges of arts and science or education. Everybody knows that engineering curricula are heavy with clock hours and with material that has to be covered but so far as the ESMWT courses are concerned, it does appear that there is a high resolve to pack much material into a curriculum in a short time. I have many other illustrations from the Army and the Navy in which they are making claims, which I have not examined personally, that the amount of time taken to master shorthand and typewriting, foreign languages, has been cut down tremendously because of the packing of material and the harder work of the students.

In addition to specificity and intensity the closely related concept of interest is getting a work out. As I have gone around in the vocational training groups and seen boys and girls, men and women working on machines, I have been amazed at the interest that shines in their eyes and keep their attention applied definitely to their work. This is something that cannot be paralleled in the courses in general education as ordinarily given in the schools. These children learners have motivation of the keenest sort.

I said children, but I am thinking of the Boeing plant in Chicago where they observe the policy of taking neither young people nor women. I saw a class of perhaps 100 people,

whose median age would be about 45 or 50, who were intensely interested and applying themselves strongly, more strongly than do many groups of youth.

The element of interest is also important in peacetime. We have deep interest now because our needs are immediate and important. As soon as the trainee learns his skill, he takes a job which will help to produce machinery which in turn will be useful to the war. All that background of motivation we have in this situation and it is difficult to get such motivation in times of peace.

In addition there is another concept that is being worked upon with very great interest at the present time, and that is the concept of instruction. In a very simple case, one of the most interesting that I have seen is the instruction of foremen under what is called the J. I. T. course of the T. W. I. Training Within Industry is one of the agencies of the WMC Training Bureau which trains foremen in short, intensive courses, and of those one is called Job Instruction Training. I was amazed at the results. I wrote a book once on how to train foremen in 350 pages. These people have processed a job instruction training course and put it on a card 2½ by 4 and have used only one side of the card. They teach the course in ten hours. It certainly is the A, B, C's of teacher education and extremely useful because we have literally millions of new men becoming trainers who have never had anything to do with people as such; they have been working on machines. When they are given ten people to lead they just do not know how to do it. To them it is a profound discovery to know that you first of all "prepare the worker" by first of all "putting him at ease." They had never thought of that before. It opens a new philosophy of life to them.

Now you ask, "Does it do any good?"

Yes, we have found that the median time that it takes these foremen to train new people as compared with the time it took before taking the course represents a saving of about 50 per cent. They are able to cut the time of training down by paying attention to a few simple points.

That is one illustration of methods of instruction being worked upon. In addition to that the vocational schools and the ESMWT courses are developing methods under pressure of getting results as rapidly as possible that should be collected and preserved for the consideration of engineering education in its upper and lower levels in times of peace. It would be a tragedy if the experiences that are being worked out here and now should be completely dissipated with the signing of a treaty of peace.

I have mentioned these four concepts of specificity, intensity, interest, instruction. A fifth is a functional and flexible curriculum.

It is considered to be bad form in the ESMWT service for an instructor who has a course and is approached by management asking for a course, for him to say, "Well, I don't have exactly what you need, but I have this course and you can send your people over to take it. I think it will do them good." That does not happen in the ESMWT because the concept of flexibility of curriculum is one that is recognized.

The upshot of all that I have said is this: Here are five concepts that are being worked on and a great deal of information is being secured. Some

of the things that have been worked out are good and some may not be significant. It would seem to me, therefore—and this is the message that I have this morning—that it is certainly within the field and may be a responsibility of this Society for the Promotion of Engineering Education to set up plans by which, in coöperation with other people, the methods and objectives of practical engineering education as it is being carried on today under the impetus of the war could be examined and recorded. Undoubtedly many such recorded facts will be very useful. A committee might very well spend its time at something much less important than gathering up these experiences and making them available for the serious, continued consideration of educators interested in engineering after the war is over.

I want to thank you for listening to this analysis which does not have much to do particularly with the war, but in my own philosophy of the place of war education in the history of education, I feel that we ought to collect everything that has emerged as contributions in times of war to utilize them in times of peace.

Experience in the Operation of an A.S.T.P. Unit*

By R. L. SWEIGERT
Georgia School of Technology

In giving a few of our experiences with the A. S. T. P. program, I would like to point out that some steps are already being taken to improve certain conditions in the operation of the program. Also, I will not include a number of administrative problems encountered since it appears to me that these are local in character and have to be solved on the basis of local conditions.

Sometime in February, the Army asked us if we would take 500 students under the Army Specialized Training Program, these students to report early in March. This number was accepted, and for the next few weeks we were in a state of planning for a program without being able to get any definite information about it. This, naturally, produced a certain degree of confusion; however, we were not quite as puzzled as a certain philosopher.

The proprietor of a tanyard was anxious to fix a suitable sign to his premises that would signify the type of his business. At last a happy thought struck him. He bored a hole through the doorpost and stuck a calf's tail into it with the tufted end outside.

After a while he noticed a solemn-faced man standing near the door looking at the sign. The tanner watched him for a moment and then stepped out and addressed him: "Would you like to buy some leather?"

"No," was the reply.

"Perhaps you have some hides to sell?"

"No."

"Are you a farmer?" continued the tanner.

"No."

"What are you, then?"

"I am a philosopher. I've been standing here for nearly an hour trying to find out how that calf got through that hole."

We believe we know now how the calf got through that hole.

We were told to expect all fourth term students in our first quota of students and attempted to plan accordingly. However, several hundred unclassified students ultimately appeared without records or transcripts. One hundred of these were sent back because of not being qualified for advanced work and were over age for basic work.

We classified the students on the basis of such information as could quickly be obtained concerning their past records. On the basis of this information there were 120 students in the first term, 60 in the second term, 80 in refresher work, approximately 60 each in the fourth term in Civil Engineering, Mechanical Engineering, Chemical Engineering, and Electrical

* Presented at the Fiftieth Anniversary Meeting, S. P. E. E., Chicago, Ill., June 18–20, 1943.

Engineering, and 30 in the fifth term in Chemical Engineering, making a total of over 500 students. We may have been the only school receiving a full quota.

These men varied in academic background and in experience from high school graduates to Ph.D.'s. Some of these men were about 40 years old and the oldest, I believe, was 47.

The attitude of these students has been reasonably good. However, many did not want to come and this affected both their attitude and their work. These students were given a test and those passing it were ordered to report regardless of the student's position or interests. After two and one-half months, both attitude and work have improved.

There were no irregular students. A student who was partially deficient had to be put either in the term corresponding to the work in which he was not deficient or into an earlier term corresponding to the work in which he was deficient so that the deficiency could be made up. Whether he was placed in one term or the other depended upon the importance of the deficiency. If this were in an important prerequisite for advanced work, it was essential that this deficiency be made up.

Deficiency reports for the Army students were turned in every four weeks.

The following figures were tabulated from the two reports turned in.

From the first four weeks report:

Students with no deficiencies	60%
Students with one or more deficiencies	40%

Deficiencies by subject for the first report period were as follows:

Mathematics	22%
Physics	22%
Chemistry	20%
Chemical Engineering	8%
Mechanical and Civil Engineering	0%
Electrical Engineering	50%
Drawing	7%
English, History	2%

This record is somewhat better than for our regular students whose deficiencies in mathematics and physics may run as high as 30 per cent.

From the second four weeks report:

Students with no deficiencies	80%
Students with one or more deficiencies	20%

At the end of the second four weeks, 5 per cent were sent back to camp, being considered as unable to profit from further training.

A deficiency in a subject means a failure and not a condition. Comparing the two reports, 60 per cent had no deficiencies at the end of the first four weeks, and 80 per cent had no deficiencies at the end of the second four-week period.

There were three reasons for this improved record for the second four weeks as compared with the first four weeks. Many who had become rusty in academic subjects and who were out of practice in studying began to get back into academic stride. The Army improved its handling of the men; they became more satisfied, and particularly, study conditions were improved. Some instructors in such subjects as mathematics and physics were made available at night to aid students who were having difficulty. However, this arrangement did not prove as satisfactory as we had expected.

The present Army group is approaching the end of its initial term and little change is expected from the record of the second four-week period. The number who will be able to advance to the next term is expected to be about 80 per cent.

The principal problem seems to be

that of screening and classifying the students. The students which we received, as has already been indicated, varied from high school graduates to Ph.D.'s and included some who had failed out of college. Not only the work but also the quality of work is important in classifying students.

The classifying of liberal arts students presents some difficulty as they may lack certain essentials, such as drawing, for advanced standing. The students who have a background in mathematics, science and drawing lend themselves better to classification.

Many of the students received could have been used in special services without the A. S. T. P. because of their past education and experience.

An Army colonel stated to me that experienced Army men should classify the men, but it seems preferable that the schools do this job since they are responsible for the instruction. A good job of instruction depends very definitely on proper classification.

It is hoped that the STAR schools will function and eliminate the difficulties that we encountered, and that it will be possible in the future to have groups of men report, already classified into the proper term and curriculum. However, some of the preliminary information coming in from STAR schools has not been as encouraging as it might be and these schools may not create the Utopia that we hope they will.

There are some undesirable arrangements of courses which we will not comment upon here as we do not yet have any specific experience to verify our present point of view and we are only giving experiences here.

I do not know if it is a good thing to make comparisons of the two service branches but it will be interesting to watch the Navy program unfold and to compare the two programs. We not only have an Army program which will be increased but we will also have about 1,000 Navy men.

We are already receiving transcripts for the advanced Navy students. We will be able to classify them, become acquainted with them on paper, and be in a much better position to go ahead with them than we were with the Army students. We are expecting less confusion, less difficulty than we faced with these Army men. We are expecting another group of Army men, but so far we have not received any information about them and do not suppose we will until they come from the STAR schools.

From our past experience, I am inclined to think that all the schools which receive these men ought to receive their transcripts as well. If we have the complete records we can make student classifications, and correct any classification that might not seem in order based upon our local situation.

Military control needs to be a minor rather than a major item if standards are to be maintained. One of the major contributing factors to the better results obtained during the second four-week period was the relaxing of military control in connection with time available for study.

In conclusion, let me say that with the proper classification of the students and with a proper appreciation by the military authorities of the educational environment necessary for good work, the engineering schools can and will do the job expected of them.

Training of Women in Engineering*

By C. WILSON COLE

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Supervisor of Engineering Personnel Bureau, Curtiss-Wright Corporation

Seldom in the history of either education or of industry has a more unique problem in the training of personnel been faced than the present one of introducing large numbers of women into the engineering profession.

National statistics indicate that during the last decade less than twenty-five women throughout the United States received engineering degrees each year. Though it is true that many outstanding engineering institutions finally removed long-standing entrance barriers to women, few have actually encouraged them to enter a profession generally looked upon as being "reserved for men only."

Drastic efforts currently being put forth by many companies to persuade women *en masse* to become "engineers" appear paradoxical compared to the many years of rebuff in the past. This change of attitude, however, has been a process of evolution even though it has taken place in less than two years.

In order to meet the industrial expansion resulting from demands for increased war production, large and small concerns alike were forced to turn to a labor supply other than male graduate engineers. It is pertinent to note that during the college year of 1941–42 there were approximately 6,342 engineers who entered the employment of private industry. During the current year of 1942–43 it is estimated that less than 4,000 will have the opportunity of accepting a position in private industry, and many of these may later find it necessary to enter military service.

One of the first major attempts to develop a substitute supply of personnel to fill engineering needs was the Engineering, Science, and Management Defense Training, now known as Engineering, Science, and Management War Training. During its three and one half years of existence, this branch of the U. S. Office of Education has trained over one million people. During the first year or two most of the training given by the ESMWT was of a pre-employment nature, but current training is almost exclusively given to persons now employed in industry. Excellent results have been obtained by this latter method, but unfortunately it has not adequately assisted in training unskilled persons for positions of a high level. The reason for this is that the short-term nature of the courses given seriously limits the amount of material that can be given both in scope and penetration.

Consequently, with all due respect for the excellent intentions of the Of-

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fice of Education and the results they have obtained through the ESMWT, industry has been forced to take supplementary steps of its own to develop new sources of supply and more comprehensive methods of training.

Some companies made a concerted effort to hire older men—men who either lacked an engineering background altogether or whose engineering backgrounds were obtained many years ago without subsequent experience. These men were brought directly into the organization and trained on the job. One company, however, actually sent them to an engineering school for a short time prior to their placement within the organization.

All these efforts were only partially successful and were eventually curtailed because of the two following main factors:

1. It soon became obvious that older men were not sufficiently flexible in their thinking to absorb present day concepts and applications of engineering, particularly as it is practiced in the aeronautical industry.
2. It is impractical to employ older men for jobs that are on a beginner's level, particularly when the majority of such men have been accustomed to fairly important jobs at proportionately large salaries.

Simultaneously with the above efforts, a great many companies turned their attention to the utilization of woman power. One of the first attempts in this direction was the employment of graduate college women who had majored in mathematics and/or physics, in the hope that such women could be successfully trained directly on the job.* It was soon realized, however, that it would be difficult to teach many of these women to apply their *academic* mathematics and physics to *practical* engineering problems.

This experiment has been promising at least in part. There have been several notable examples within the aeronautical industry of women who have been promoted to responsible positions in structural and stress analysis during the past year or two.

Industry again failed, however, to find a solution to its overall problem. This was true for the following main reasons:

1. As with all of the other approaches mentioned above, the supply of qualified people was nowhere near adequate to meet the total need. From figures obtained through questionnaires sent to a high percentage of colleges throughout the United States, it was estimated that there were less than 600 women, majoring in mathematics and/or physics, being graduated from colleges in this country each year.
2. That women in general have had little exposure to mechanical things, and the mere fact that some women have taken mathematics or physics is not neces-

*Note: Last year Wright Aeronautical Corporation (the engine division of Curtiss-Wright) employed 25 such women and have attempted since that time to train them for experimental test engineering duties. Their training to date has consisted mainly of guided working experience in several departments closely allied to the Test Engineering section where they will be placed at the completion of their training a few months hence. This experience has been supplemented by a certain amount of classroom work.

sarily any indication that they are endowed with "mechanical horse-sense," or that they can do work of a highly technical nature.

During September last year it was realized that in spite of the efforts made up to that time industry was still faced with a serious shortage of engineering manpower which promised to become far more acute by January, 1944.

Searching for an entirely different approach to the problem, Curtiss-Wright devised a plan which has been named the Engineering Cadette Program. Under this plan young women with at least two years of college education were to be employed as Engineering Cadettes and assigned to an engineering university for their training. This reduction in the educational requirement immediately enlarged the available source of woman power, but at the same time it increased the complexity of our training program.

After making a preliminary study, the following basic decisions were reached:

1. That of the three divisions of Curtiss-Wright (namely, airframe, propeller, and engine) the Cadette program would be used by the airframe and propeller divisions only. This decision was founded on the belief that many engineering universities are admirably staffed and equipped to train personnel for aircraft and propeller work, but that few universities, if any, have the experience or the laboratory facilities to teach experimental engineering of aircraft engines.*
2. That in order to recruit sizeable numbers of Cadettes, minimum requirements for employment and enrollment in the program should be established realistically. As a result, four essentials were agreed upon:
   (*a*) *Education*—At least two years of college including at least one year of college mathematics or its equivalent.
   (*b*) *Age*—At least eighteen years.
   (*c*) *Previous scholastic record*—Upper third of class in related subjects and better than average in non-related subjects.
   (*d*) *An awareness of the engineering profession*—(In most cases among the present Engineering Cadette group this was obtained through personal acquaintance with an engineer.)
3. That the curriculum to be taught by the universities should be custom-built, deleting any subjects which could be considered non-essential. However, it was agreed that sufficient fundamental should be included in order that the Cadettes would be at least potentially qualified for *subsequent up-grading*.
4. That the program should be of ten months duration, commencing February 15, 1943, and terminating on December 15, 1943.
5. That the company should contract with the participating schools for

*Note: Plans are being formulated to inaugurate a program whereby college girls of the type referred to above will be employed directly by the engine division. They will be trained in the company's experimental engine test laboratories supplemented by classroom lectures and demonstration.

the cost of tuition and room and board. In addition, the Cadettes should be paid $10 per week, which would establish them as employees and distinguish them from students endowed with industrial scholarships.

From this preliminary stage the plan was developed in four phases:

1. Selection of the universities in which to conduct the program.
2. Recruitment of applicants.
3. Preparation of a curriculum.
4. Development of an administrative organization.

I. Selection of Universities

With valuable assistance from the Society for the Promotion of Engineering Education, every accredited engineering institution in the country was queried in respect to our proposed plan. Subsequently, seven schools were offered the program and contractual negotiations were instigated. These schools were: Cornell University, Iowa State College, University of Minnesota, Pennsylvania State College, Purdue University, Rensselaer Polytechnic Institute, and University of Texas.

It is apropos to mention here that not only did each of the above seven schools accept our offer, but did so recognizing the fact that from an educational point of view this program offered a definite pioneering challenge.

II. Recruitment of Applicants

Because of the necessity of obtaining a large number of applicants, our recruiting program was set up on a nationwide basis. We contacted over 1,000 colleges with the coöperation of the American Council on Education to arrange for interviews to be conducted by female members of our Personnel Department. As a result of this procedure, nearly 4,000 girls were interviewed and 719 were finally accepted. Those who were accepted represented 44 states, 300 colleges, and entered our program with backgrounds varying widely as shown by the following table:

Age

No. Students	*Age*	*No. Students*	*Age*
*6	17 years	11	24 years
116	18 years	12	25 years
254	19 years	1	26 years
189	20 years	1	27 years
87	21 years	1	28 years
24	22 years	1	29 years
12	23 years	4	30 years

Average—19.6 years

* These were accepted as they will be 18 years of age before Dec. 15, 1943.

College

No. Students	*Yrs. Preparation*
†54	under 1 year
163	1–1½ years
121	1½–2 years
217	2–3 years
108	3–4 years
56	over 4 years

Average—2.5 years (approx.)

† These individuals were accepted with below stated minimum requirements because they had other qualifications which justified their employment.

Mathematics

No. Students	*Yrs. Preparation*
220	less than 1 year
214	1 year
110	1½ years
71	2 years
48	2¼ years
23	3 years
11	3½ years
22	4 years

Average—1 year, 3 months

This table indicates conclusively that the amount of training and the method of presenting such training would of necessity vary between the upper and lower strata of the ranges presented above.

III. Preparation of Curriculum (see Appendix)

In designing the curriculum it was necessary to present essential fundamentals and their industrial applications. Consequently, effective collaboration between our company technicians and faculty members was obtained for the writing up of an outline of subject material. A copy of the resultant course of study is attached as an appendix to this paper. Some of its outstanding characteristics should be discussed at this point.

1. In order to obtain close direction and control over the method of teaching each and every course of the Cadette program, the schools were specifically requested by the corporation to designate a responsible official of the schools as Director of the Course. It was further requested that all faculty members teaching for Curtiss-Wright be made responsible to this Director of the Course. This type of faculty organization was in many schools a distinct innovation over previous departmental entities.
2. In order that the instructors would have some appreciation of the working methods used by Curtiss-Wright engineering departments, it was arranged for them to visit our plants and to consult with our technicians. Provisions were also made for Curtiss-Wright to send some of its personnel to the university to give special lectures, to conduct seminars, and to explain the applications of subjects being taught.
3. It was the general concensus that faculty members would be required to place more emphasis on individual accomplishments than would be normally true with privately enrolled students. The major difference in this case was that the Cadettes are employees and therefore should be trained for utilization in the plant in some capacity at least, even though the total number being trained will not in all cases absorb the same amount of subject material.
4. The curriculum incorporated subject material which would prepare the Cadettes to perform such duties as detail and minor layout drafting and design, computors in weight and balance determinations; liaison engineers for design change and shop contact work between engineering departments and fabrication and assembly departments.

   It is a foregoing conclusion that "on the job" training will be given to the Cadettes to supplement the preliminary material covered at the universities. Opportunity will therefore be open to each and every Cadette to be up-graded within the organization. This will be dependent solely on individual initiative and inherent ability.

The following is a brief description of each subject being taught:

Mathematics

Acknowledging the diversification of mathematical background among the

Cadettes, the mathematics course was so written as to give a review of elementary subjects, such as algebra and trigonometry. Slide rule and logarithms were inserted during the first few weeks. Subsequent to the above review, the following topics are covered in order: Areas and Volumes; Analytical Geometry; Applied Differential and Integral Calculus; and Aircraft Problems. Each school has divided its total group into three or four sections according to the individual abilities of the students as determined during the first month of the course. Each section will complete as much of the above material as possible. The slower sections will probably skip Applied Differential and Integral Calculus, and the advanced sections may, in addition to the above topics, devote some time to Differential Equations.

Every effort has been made to present the above subjects as tools to be used in solving current problems of design, structural analysis, aerodynamics, etc. Calculus, for example, is definitely being taught as a tool to be used in mechanics. At the same time, this treatment makes it possible to cover each subject in considerably less time than has been usually possible when taught from a theoretical point of view.

From the experience we have had to date, several observations are possible:

1. Algebra and trigonometry, when presented in the applied manner as outlined, were different from anything the Cadettes had previously been taught in these subjects. They were so different that even those girls who had completed two to four years of mathematics elsewhere were able to make good use of the review.
2. One of the surprising discoveries made so far was that many of the Cadettes having a deficiency in mathematical preparation have grasped the above subjects as well as those who had a preponderance of mathematics prior to entrance in the Cadette program.
3. The schools have found it possible to rearrange the sequence of topics discussed in order to cover specific material before it is applied in mechanics or any other courses.

Job Terminology and Specifications

Recognizing the fact that girls have little knowledge of aeronautical terminology or of the simple principles of airplane theory, we prepared a course to compensate for this deficiency. As the material being presented in this course is new to all students alike, we have not felt justified in dividing the group into fast and slow sections.

The entire course has been broken down under the following major headings:

1. The Airplane.
   This is a brief outline of the airplane itself and its components, with special emphasis on terminology.
2. Aeronautical Industrial Organization.
3. Function and Operation of Curtiss-Wright Engineering Department.
4. Aerodynamics and Theory of Flight.
   It has not been our intention to cover the subject of aerodynamics thoroughly. However, sufficient material will be given in order that the Cadettes will have a workable understanding of aero-

dynamics and its relationship to the design of an airplane.

From experience to date, several observations are possible:

1. That the subject material was foreign to the girls because of their lack of exposure to such things in the past. Consequently, additional measures were taken to teach them "the fundamental concepts"; for example, model building, plane spotting, and laboratory demonstrations were used.
2. This course was developed as the keystone of our whole program, as it has become the point of convergence where the real application of all other subjects becomes apparent. Several of the schools have indicated that serious thought will be given to post-war engineering curricula from the point of view of incorporating such a course as our Job Terminology in the Freshman year of engineering.
3. That visual guides and practical demonstrations have been much more successful in teaching the Cadettes than straight lecture work.

Drawing

The Cadettes will be required to spend a considerable length of time on the drafting board after they are transferred to the plants. Consequently, every Cadette must be given a thorough ground-work in problems of drawing and design. The Curtiss-Wright Drafting Manual and Standards Book is being used throughout this course. This procedure makes it mandatory that the Cadettes prepare their drawings in accordance with company procedures and requirements, with particular emphasis on lettering, use of vellum, and use of the decimal system. Drawing problems are based on typical blue prints and parts furnished by the company, making it possible for the Cadettes to become familiar with the various parts of an airplane and to become cognizant of the relationship between manufacturing and design.

A minimum of forty to fifty hours is being devoted in all schools to the teaching of intersections and projections as applied to aircraft layout problems. This emphasis on applied descriptive geometry is, of course, particularly pertinent to aircraft design. From experience we have had to date, several observations are possible:

1. That in a manner similar to engineering students throughout the country our Cadettes became imbued with the idea that a drafting job would not measure up to their training and ability. The only way to counteract this obsession has been to continually emphasize *designing* rather than drafting and to repeatedly point out that top notch designers began their careers as draftsmen.
2. Many of the schools have rated the Cadettes as superior to freshman engineers in drafting, particularly in reference to neatness and accuracy. Many are having trouble, however, with three-dimensional problems and with projections. Here again is a place where visual aids and actual parts must be used to help the Cadettes to "see" what they are trying to do.
3. Previous efforts by industry to use women for drafting have indi-

cated that although women might be good draftsmen, they would seldom be proficient in design. We have attempted through the Cadette program to give a sufficiently comprehensive training (which has been lacking before in other attempts) so that the Cadettes will eventually be qualified for such advancement. Our results in this attempt will not, of course, be determined for several years.

Mechanics

The course in mechanics as written represents a combination of physics, strength of materials, engineering mechanics, and structural analysis. It is obvious that only a part of the material usually covered under the above subjects could be presented in ten months, yet the resultant course does cover, in both scope and penetration, sufficient subject material to qualify the better girls for work in structural analysis. At the same time it enhances the background of those going into other types of technical work.

To further insure that the subject material would be presented from an engineering point of view, we refrained from using academic terminology such as "physics" in any connection with this course and the schools agreed to use engineering instructors to teach the course. It is the opinion of several outstanding experts on structural engineering that the structural course being given in connection with the Cadette program is exceptionally outstanding and should prove equally effective if included in standard engineering curricula.

From experience we have had to date, several observations are possible:

1. As expected, wide diversity in ability is showing up among the Cadettes. Each school has, therefore, sectioned its unit, and each section will proceed to cover as much ground as possible. It is a fallacy, however, to presuppose that proficiency in mathematics assures equal proficiency in mechanics or vice versa.
2. At the outset practically all the Cadettes had difficulty with mechanics. Their attempts to study mechanics in the same way as English or History proved a dismal failure. When the instructors realized this problem and made efforts to instruct the Cadettes accordingly, a high percentage of the Cadettes were able to take mechanics in their stride.
3. The presentation of mechanics proved perhaps more conclusively than the presentation of any other course that demonstration and visual aids are essential in teaching engineering to women.

Properties and Processing of Aircraft Materials

This course was introduced into our program primarily for the following reasons:

1. Repeating a statement made several times heretofore, girls are confronted with a serious handicap when entering the engineering profession because as children they had never been exposed to everyday mechanical things. We recognize, therefore, that considerable time and effort must be spent in acquainting them with actual shop operations.
2. It was our opinion that the only way to give the Cadettes the op-

portunity of rising above the level of draftsmen would be to indoctrinate them with the problems of shop procedures, shop tools and their operations as used in aircraft engineering, the importance of understanding mass production tools and their relationship to correct design engineering, airplane parts and assemblies, and production engineering in the aircraft industry.

From experiences we have had to date, several observations are possible:

1. Although obviously clumsy at the outset, the Cadettes have mastered with a great deal of proficiency the handling of tools and the operation of machines.
2. As we expected, this course has greatly assisted the Cadettes in understanding the whys and wherefores of the subject material taught in other courses.

Supervised Study and Methods

One of the greatest innovations in the entire Cadette program was the inclusion of the course called "Supervised Study." It was originally intended to be an organized class in analytical thinking. It has evolved, however, as a period of time set aside during which instructors are available for group or individual assistance. During this period Cadettes may prepare any outside assignments they desire. They are encouraged, however, to consult the instructor present for guidance in study methods and for assistance in clarifying fundamental principles which might be hazy and confused. As pointed out previously, our goal in the Cadette program is to teach as much as possible to each individual and to the highest degree of which she is capable. Through the Supervised Study and Methods classes the instructors have this opportunity.

IV. Administrative Organization

Conducting a training program for 700 women in seven widely separated universities for subsequent placement in five plants of Curtiss-Wright presented a formidable problem of organization and administration. The following steps were taken:

1. The initial ground work was accomplished by a centralized bureau operating in behalf of the various plants of Curtiss-Wright. Each plant, however, contracted directly with one or two schools as the case might be, placed the Cadettes on its own payroll, and subsequently took over the direct administration of its own part of the program.
   The centralized office will continue to act as a coördinating unit to insure maximum uniformity in all activities and procedures.
2. A female personnel supervisor was assigned to each one of the seven universities. It should be pointed out that although the Cadettes are regarded by the company as employees, they are isolated many miles from their plant and are intermingled with regular students. This means that our personnel supervisor must be the link between the school and the company, the resident "boss" and counselor of the Cadettes in their personal problems—all these at the same time. There is no question that the efforts of these women supervisors have, to a large measure, been responsible for the success of the program to

date and for the high level of morale maintained among the Cadettes. The spirit prevailing among all 700 girls of fervent enthusiasm and conscientiousness has no doubt been influenced considerably by the activities of the resident personnel supervisors.

The Cadette Engineering Society

Shortly after the Cadette program started, interest was developed among the Cadettes to organize an engineering society, through which it would be possible for the Cadettes to obtain pertinent information and data concerning the engineering profession as a whole and knowledge of Curtiss-Wright in particular. Consequently, a society now known as the Cadette Engineering Society was organized simultaneously at all units. This group is, of course, a temporary expediency and has been organized to

CURRICULUM FOR CURTISS-WRIGHT ENGINEERING CADETTE PROGRAM
AIRPLANE DIVISION SECTION

To be given at: Cornell University, University of Minnesota, Purdue University, Iowa State College, Pennsylvania State College, University of Texas

Entire course of 44 weeks to be given from February 15, 1943 to December 15, 1943. Division made into two sections (A and B) of 22 weeks each.

A-22 weeks	Hours	B-22 weeks	Hours
(1) Engineering Mathematics	6	(1) Engineering Mathematics	3
(2) Job Terminology and Specifications	3	(2) Theory of Flight	3
(3) Elements of Aircraft Drawing and Standards	9	(3) Aircraft Drawing and Design	12
(4) Elementary Engineering Mechanics	6	(4) Strength of Aircraft Structural Analysis (a) Materials 11 weeks (6); (b) Materials Testing 11 weeks (3)	9
(5) Properties and Processing of Aircraft Materials	6	(5) Aircraft Production Methods and Operations	3
(6) Supervised Study and Methods	8	(6) Supervised Study and Methods	8
(7) Physical Education	2	(7) Physical Education	2
Total	40	Total	40

Course (A-1)—132 hours
Course (A-2)— 66 hours
Course (A-3)—198 hours
Course (A-4)—132 hours
Course (A-5)—132 hours
Course (A-6)—176 hours
Course (A-7)— 44 hours

Total Hours—1760

Course (B-1) — 66 hours
Course (B-2) — 66 hours
Course (B-3) —264 hours
Course (B-4a)—132 hours
Course (B-4b)— 66 hours
Course (B-5) — 66 hours
Course (B-6) —176 hours
Course (B-7) — 44 hours

meet current needs. Most of the Cadettes have subsequently become associated with student branches of various national engineering societies and these connections will probably be continued when they enter the plant.

Conclusion

I have dwelt considerably upon a discussion of the Curtiss-Wright Engineering program only because it represents a radical departure from previous training methods and because it embraces many fundamentals inherent to present and future educational problems.

Above all else this endeavor to accomplish closer collaboration between industry and education is a promising prognosis of post-war improvement of educational tie-up with their customers —the industries.

Then again, the final results should fairly accurately predict the future place of women in the engineering profession.

Many other companies have already followed Curtiss-Wright in instigating or planning programs of a similar nature to the Cadette plan.

I am sure that I can speak in behalf of other companies as well as Curtiss-Wright in stating that regardless of all efforts being made to supply substitute engineers, industry will continue to have urgent need of four-year graduate engineers for the duration of the war. There is no substitute for the graduate engineer who has in addition to his degree at least some experience in industry and particularly in the company employing him. To preserve industry's ability to contribute to the war effort, provisions must be made to safeguard such valuable manpower.

A–I

Engineering Mathematics—6 hours per week for 22 weeks

1. *Logarithms*—12 hours

   Definition of logarithms; common logarithms for multiplication, division, powers, and roots. Natural logarithms and conversions.

2. *Slide Rule*—12 hours

   Addition and subtraction with simple scales; relationship to logarithms; multiplication, division, powers, and roots to slide rule; rules for decimal points.

3. *Trigonometry*—60 hours

   (*a*) 42 hours—Definitions, functions, solution of right triangles.

   (*b*) 18 hours—Solution of general triangles, and problems. Functions of double angles.

4. *Areas and Volumes*

   (Coördinate with manual and handbook)

   Areas of plane figures; volumes and areas of surfaces of prisms, cones pyramids, frustums; volumes of revolution (include Simpson's rule and Pappus's rule). Centroids of simple areas and volumes. Use of planimeter.

5. *Review of Algebra*—30 hours

   Through quadratic equations.

B–I

3 hours per week for 22 weeks

1. *Analytical Geometry*—33 hours (to be taken by all sections)

   Rectangular coördinate systems; properties of conic sections; brief treatment of polar coördinates.

2. *Applied Differential and Integral Calculus*

(This course is to be covered only by those advanced sections capable of doing so.) Emphasis should be made on application of aircraft problems.

3. *Aircraft Problems*—33 hours (to be taken by all sections simultaneously). (Construction of graphs and charts.)

Graph paper, rectangular and polar coördinates; logarithmic papers; construction of charts; graphic solution of equations; and curve plotting.

Plotting of normals and tangents to irregular curves.

Construction of graphs as computing aid.

This subject will be treated substantially as outlined. The outline below is not intended to be a hard and fast requirement. It is merely intended as a suggested development of this topic.

Kinds of Graph Paper

Rectangular Coördinates
Graphs of Simple Functions

Non-linear Functions
Graphs of Functions

Polar Coördinates
Graphs of Functions

Logarithmic Paper
Graphs of Logarithmic Equations

Semi-Logarithmic Paper
Graphs of Logarthmic Equations

Construction of Charts
Factors Governing the Selection of Charts

Ratio Charts
Graphic Comparisons
Cumulative Charts

Graphical Solution of Equations

Curve Plotting, Empirical Equations

Curve Plotting, Straight Line Law, Method of Averages

Curve Plotting
Method of Least Squares

Curve Plotting
Fitting a Curve of the Power Series
A Curve of the Second Degree

Use of Logarithms in Curve Plotting

Other Curve Types
Exponential Curves
Hyperbolic Curves

Special Parabolic Law
Method of Averages Applied to General Parabolic Law

Plotting of Normals and Tangents to Irregular Curves

A–II

Job Terminology and Specifications—6 hours per week for 22 weeks

1. *The Airplane*—9 weeks (27 hours)

Brief outline of the airplane—

a. The ABC of flight—suggested use of film.
b. Types of military and commercial aircraft.
c. Airplane components and their functions.

1. Airplane
2. Propeller
3. Engine
4. Accessories

Suggested Books

CAA Bulletin—The Airplane and Its Parts (Pre-Flight)

Lockheed's Aircraft Design Sketchbook
Otis & Page—Pre-Flight Aeronautics (prepared by Bureau of Education, published by Macmillan for highschool use)
Shield's Theory of Flight and the Aircraft Engine

2. *Aeronautical Industrial Organization*—2 weeks

3. Function and Operation of Curtiss-Wright's Engineering Department—11 weeks

This course should be developed to show the application of material given under the other four. It should be a drill class of questions and answers using as a reference the *Engineering Manual and Procedure*. In addition, the material given in the Engineering Manual should be developed from a processing and usage point of view. (It is recommended that the instructor giving this course visit the Curtiss-Wright plant.)

B–II

Aerodynamics and Theory of Flight—3 hours per week for 22 weeks

1. *Fundamental Aerodynamics of the Airplane*
   - *a.* Standard air
   - *b.* Elementary formulas and equations
   - *c.* Parasite resistance
   - *d.* Interference resistance

2. *Air Foils*
   - *a.* Lift and drag characteristics
   - *b.* Characteristic curves
   - *c.* Pressure distribution and center of pressure
   - *d.* Criteria for the selection of airfoils
   - *e.* Tapering wings
   - *f.* Aspect ratio and its effect
   - *g.* Reynolds number
   - *h.* Compressibility effects

3. *Maneuvers*
   - *a.* Rectilinear flight
     1. Climb
     2. Glide
     3. Dive
   - *b.* Curvilinear flight
     1. Banking
     2. Turning
     3. Stalling
     4. Spinning
     5. Special maneuvers

4. *Elements of Stability and Control*
   - *a.* Static stability
   - *b.* Dynamic stability
   - *c.* Longitudinal stability
   - *d.* Lateral stability
   - *e.* Directional stability and control

5. *Design Consideration*

   Performance, specification, and charts

6. *Load Factors*

   Development and use (2 weeks minimum)

7. *Wind Tunnel*

   A. Demonstration

A–III

Elements of Aircraft Drawing and Standards—9 hours per week for 22 weeks

Based on Curtiss-Wright drafting manual and standards book, elements of drawing to include use of instruments; upper case lettering through-

out the course (slant and vertical); line essentials, sketching; orthographic projections; tracing; auxiliary views and sections; dimensioning, limits and tolerances; fits; developments, intersections and projections; isometric drawings.

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright). Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

B–III

Aircraft Drawing and Design—12 hours per week for 22 weeks

1. Detailed drawings of actual airplane parts
   - *a.* Detailing of wood parts (Purdue University only)
   - *b.* Detailing of sheet metal parts
   - *c.* Detailing of machined parts and forgings
   - *d.* Detailing of welded parts
   - *e.* Detailing of castings
2. Assembly drawings
3. Layout and development

Drawing problems to be based on typical blue prints and parts furnished by Curtiss-Wright with work done chiefly on vellum, tracing paper and some cloth (furnished by Curtiss-Wright). Periodical blue print checks are to be made. All drawings should be dimensioned on the decimal system even though the samples furnished will probably all be dimensioned on the fraction system.

Note: A total of forty to fifty class hours should be spent on intersections and projections as applied to aircraft layout problems. This can be included either in the second eleven weeks of A–III or in the first eleven weeks of B–III.

A–IV

Elementary Engineering Mechanics—6 hours per week for 22 weeks

1. *Introduction*—10 weeks

   Fundamental concepts dealing qualitatively with the following:

   Force; weight; mass; density; specific gravity; lever; pulley; gears; screw; hydraulic and pneumatic pressure systems; tension; compression; flexure; functions of columns; beams, tension members; brittleness; ductility; hardness; friction; viscosity.

2. *Statics and Dynamics*—12 weeks

   The following items should be covered on the basis of qualitative determinations and that liberal use be made of problems based on aircraft design:

   a. Statistics—7 weeks

   Force, vectorial representation, couples, combination and resolution of forces, concurrent and non-concurrent force systems, reactions, space systems, truss analysis, buoyancy, metacentric height.

   b. Dynamics—5 weeks

   Laws of motion, linear and angular velocities, acceleration, energy, work, inertia, momentum, impact, motion on inclined plane, friction.

B–IV

1. *Strength of Materials*—6 hours per week for 11 weeks
   - *a.* Stress, strain, elasticity, proportional limit and yield point, tension, compression, shear.
   - *b.* Joints—riveted and welded under direct and eccentric loads. Simple pressure vessels.
   - *c.* Beams—load diagrams, reactions, moment and shear diagrams, moment of inertia, stress and tension, compression, shear (longitudinal and transverse), deflection using handbook methods, fixed and continuous beams.
   - *d.* Beam Deflection—fixed and continuous beams. (This topic to be taken up only if sufficient time can be found to approach the subject from the standpoint of fundamental concept.)
   - *e.* Aircraft Loads—3 to 4 periods (As specified in government publications on airworthiness)
2. *Aircraft Structural Analysis*—6 hours per week for 11 weeks

   The following topics should be covered in the eleven weeks devoted to aircraft structural analysis.

   a. Columns:
      1. Euler column formula
      2. End restraint
      3. Other column formulae
      4. Design of tubes in compression

   b. Torsions:
      1. Solid sections
      2. Thin circular sections
      3. Membrane analogy
      4. Allowable stresses for thin tubes
      5. Design of round tubing
      6. Torsion of non-circular thin cylinders
      7. Torsion of open sections
      8. Comparison of open and closed sections in torsion

   c. Combined Stress at a Point
      1. Biaxial stress
      2. Shear and normal stress

   d. Buckling of Sheet
      1. Single panels in compression
      2. Single panels in shear

   e. General Design Consideration
      1. Stress concentration
      2. Fatigue
      3. Weight reduction
      4. Use of standard parts
3. *Materials Testing*—3 hours per week for 22 weeks

   A suggested breakdown of this course, based on the original outline, is as follows:

   - *a.* Tension testing
   - *b.* Compression testing
   - *c.* Shear testing
   - *d.* Bending
   - *e.* Buckling
   - *f.* Torsion of test specimens
   - *g.* Buckling of columns
   - *h.* Thin web beams
   - *i.* Loading and vibration of major assemblies
   - *j.* Torsion of major assemblies

   It is recommended that this outline should be covered completely insofar as Items *a.* through *f.* are concerned. If facilities are not available for handling the remaining items, it is suggested that this time be devoted to additional work in the wind tunnel laboratory, or to the preparation of technical reports.

A–V

Properties and Processing of Aircraft Materials—6 hours per week for 22 weeks

1. *Shop*—4 hours per week for 22 weeks

(To be given simultaneously with lectures (*a*) and (*b*))

Aim: To Familiarize the Student with Shop Procedures and Shop Tools and Their Operations as Used in Aircraft Engineering

a. Bench work

Use of hammer on sheet metal aluminum alloy, file, layout, and drilling of aluminum alloy, use of hand taps and dies, sheet metal layout on aluminum alloy, cutting and forming of aluminum alloy, riveting (flush, blind, and machine).

b. Lathe work

Straight turning, screw thread cutting, chuck work, boring, internal threading.

c. Milling machine work

Plane milling, index milling, production milling.

d. Shaper and planer

Surfacing and squaring.

e. Routing machine

f. Turret lathes and screw machines

Set-up and operation; production.

g. Press operations on aluminum alloys

Mechanical and hydraulic; use of punches and dies; kirksite dies, rubber dies, temporary dies and wood dies.

h. Demonstration of miscellaneous machines

Boring mills, grinders, hobbing machines, do-all machines.

i. Precision measurements

Use of instruments; use of gauges, indicators, and gauge plots.

2. *Lecture*—1 hour per week for 22 weeks

(*a*) (To be given simultaneously with shop and with lecture (*b*))

a. Manufacture of aluminum and aluminum alloys

b. Rolling, forming, and shaping of aluminum alloys.

(rolling, forging and extruding)

c. Aluminum alloys

Physical properties and specifications; demonstration of materials testing in the testing laboratory.

d. Heat treating of aluminum alloys

Annealing, hardening, anodizing. In this connection, there will be demonstrations of heat treating, heat treating equipment, and hardness testing machines.

e. Aluminum castings

Physical properties and specifications.

f. Manufacture of iron and steel

Physical properties and specifications.

g. Tool steels and other cutting materials

Physical properties and specifications; carbon steel, hi-speed steel, stellite and cemented carbides.

h. Welding of aircraft materials

Techniques and equipment; demonstration of both in the laboratory.

i. Plastics

Physical properties and specifications. (Stress application of plastics—not chemical makeup.)

j. Die casting

Production methods, physical properties and specifications; zinc base, aluminum base, and magnesium base metals.

k. Magnesium alloys

Physical properties and specifications

3. *Lecture*—1 hour per week for 22 weeks

(b) (To be given simultaneously with shop and with lecture (*a*))

a. Shop terminology and machine operations

b. Bench and hand work

Lectures dealing with specific machine tools beyond that type of work that can be accomplished in the shop, including filing, layout, and riveting of aluminum. (Emphasizing the use of aircraft materials.)

c. Lathe, turret lathe, and screw machines

d. Milling machine

e. Drilling machine

f. Grinding machine

g. Broaching

h. Surface finishing

Honing, lapping, buffing, and polishing.

i. Press working of metals

(With particular reference to aircraft machines.)

j. Measurement and measuring devices

1. *Use of Mass Production Tools in Design Engineering*

The following is an enumeration of some of the suggested topics that should be treated in this course with the emphasis on each to depend upon the past coverage of such items given in the shop course (*A.* 5) of the first semester.

a. Jigs
b. Production Machines
c. Fixtures
d. Hand Processes
e. Special Production Tools
f. Routing Machines
g. Cutting Machines
h. Forming Machines—Use of Rubber
i. Punching Machines

2. *Airplane Parts and Assemblies*

a. Spars
b. Control Surfaces and Mechanisms
c. Loading and Vibration
d. Torsion

3. *Production Engineering in the Aircraft Industry*

A. Production Methods, Equipment and Operation

1. Assembly Methods

a. Line Production
b. Sub-assemblies
c. Major Assemblies

2. Assembly of Electrical Harnesses
3. Quality Control and Inspection
4. Tube Bending—Use of Mock-up
5. Production Welding
   a. Acetylene and Electric Welding in Jigs and Fixtures
   b. Spot Welding
6. Heat Treatment, Anodizing and Plating
7. Construction of Experimental Airplanes
   a. Wooden Model
   b. Mock-up
8. Die Casting of Metals and Plastics
9. Modification Center and its Functions

B. Production Planning

C. Routing Procedure

D. Shop Liaison

The Course should be closely correlated with Aircraft Detail Design so as to bring out the importance of a good working knowledge of production methods on the part of the designer, so that he may avoid laying out a part or assembly which cannot be built in the shop, or which may involve considerable difficulty in its fabrication.

A–VI and B–VI

Supervised Study and Methods—8 hours per week for 44 weeks

Instruction in study methods to be given by mathematics and mechanics instructors. Presentation of engineering problems, emphasizing method of approach used in the solution of each type of problem. Periods to be left open as to the subject matter to be covered, but work should be directed definitely toward analytical thinking. Students' efforts to be directed toward obtaining solutions to problems by themselves, not from instructors. Assistance should be given by instructor in visualizing problems.

Additional course material should not be given in the supervised study and methods. Advanced students should not be used as tutors.

A–VII and B–VII

Physical Education—2 hours per week for 44 weeks

The committee recommends that the work in Physical Education should be given primarily from the standpoint of relaxation and recreation. Some corrective calisthenics might be included with benefit, but this should not be compulsory, nor should it take up a great deal of time. A correlation of physical training with health service activities and dormitory supervision might well be included with regard to such topics as adequate sleep, dietary advice and general health.

New Members

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HODGES, JOHN C., Professor of English, University of Tennessee, Knoxville, Tenn. C. S. Camp, J. G. Tarboux.

HOFF, NICHOLAS J., Assistant Professor of Aeronautical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Erich Hausman, E. J. Squire.

HOLDREDGE, ERNEST C., Instructor in Mechanical Engineering, University of Tennessee, Knoxville, Tenn. F. H. Thomas, R. W. Morton.

HUMMEL, ROLAND L., Instructor in Civil Engineering, University of Connecticut, Storrs, Conn. J. H. Lampe, K. P. Hanson.

JAMEYSON, BRUCE, Professor of Civil Engineering, University of California, Berkeley, Calif. Charles Derleth, C. A. Wiskocil.

JOICE, CHARLES B., Apprentice Supervisor, Torpedo Dept., Naval Torpedo Station, Keyport, Wash. H. T. Heald, J. S. Thompson.

KENYON, VAN LESLIE, Assistant Professor of Mechanical Engineering, University of Vermont, Burlington, Vt. R. G. Chapman, G. F. Eckhard.

KING, HAROLD J., Instructor in Engineering, University of Rochester, Rochester, N. Y. H. J. Conley, H. S. Gardner.

KIRKPATRICK, E. L., Associate in Physics, George Washington University, Washington 20, D. C. H. T. Heald, J. S. Thompson.

LAWRENCE, E. GEORGE, President, Lawrence Institute of Technology, Detroit 3, Mich. G. P. Brewington, F. L. Bishop.

MCENANY, MIKE V., Instructor in Electrical Engineering, The Rice Institute, Houston 1, Texas. C. R. Wischmeyer, L. B. Ryon.

MEIER, OTTO, Assistant Professor of Electrical Engineering, Duke University, Durham, N. C. W. J. Seeley, W. H. Hall.

MILLS, GUY G., Lt. Col., Assistant Physicist, Military Dept., The Pennsylvania State College, State College, Pa. F. T. Mavis, H. P. Hammond.

MILLS, PETER J., Associate Professor of Physics, Illinois Institute of Technology, Chicago, Ill. L. E. Grinter, J. C. Peebles.

MONTZ, JOHN M., Associate Professor of Civil Engineering, The Ohio State University, Columbus, Ohio. J. C. Prior, C. T. Morris.

MUNOZ, AUGUSTO A., Civil Engineer, Catholic University of Chile, 745 E. University, Ann Arbor, Mich. A. H. White, C. Upthegrove.

O'FIEL, CHARLES G., Chief, Airways Engineering Branch, Civil Aeronautics Administration, 1108 Fifth Ave., Fort Worth, Texas. H. T. Heald, J. S. Thompson.

OSBORN, ROBERT E., Instructor in Electrical Engineering, Cornell University, Buffalo, N. Y. Fred Ocvirk, R. Y. Thatcher.

PARKER, THEODORE B., Professor of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Mass. R. S. Williams, T. R. Camp.

PERRONE, SAVIOUR A., Instructor in Customer Engineering, International Business Machine Corp., Endicott, N. Y. Louis Mitchell, L. A. Emerson.

PLANCK, IVAN A., Professor of Mechanical Engineering, Indiana Technical College, Ft. Wayne, Ind. H. T. Heald, J. S. Thompson.

RIEBETH, THEODORE J., Assistant Professor of Mechanical Engineering, Marquette University, Milwaukee, Wis. F. A. Kartak, S. Scrimshaw.

RUHL, ROBERT C., Head, Dept. of Civil Engineering, Indiana Technical College, Ft. Wayne, Ind. Wm. Knapp, Geo. Lommel.

SEAL, PHILIP M., Instructor in Electrical Engineering, Purdue University, Lafayette, Ind. L. E. Beck, G. V. Mueller.

SEVERANCE, DONALD P., Assistant Registrar, Massachusetts Institute of Technology, Cambridge, Mass. J. C. MacKinnon, C. E. Tucker.

TURNER, ARTHUR W., Educational Adviser, International Harvester Co., Chicago, Ill. L. J. Fletcher, E. G. McKibben.

VAN GORDON, J. H., Chairman, Division of Engineering Education, Business Machines Corp., Endicott, N. Y. Louis Mitchell, L. B. Howe.

WILKINSON, MEARLE W., Professor of Dental Materials and Metallurgy, University of Southern California, Santa Monica, Calif. H. T. Heald, J. S. Thompson.

WINSLOW, RALPH E., Head, Dept. of Architecture, Rensselaer Polytechnic Institute, Troy, N. Y. W. O. Hotchkiss, L. W. Clark.

WLADAVER, IRWIN, Instructor in Engineering Drawing, Franklin and Marshall College, Lancaster, Pa. T. A. Distler, W. G. Smith.

YAVITCH, JACOB, Assistant Professor of Mechanical Engineering, Villanova College, Villanova, Pa. W. M. Gorman, J. S. Morehouse.

ZEDER, JAMES C., Chief Engineer, Chrysler Corp., Detroit 31, Mich. A. H. White, A. H. Lovett.

ZWEIG, FELIX, Assistant Professor of Electrical Engineering, Yale University, New Haven, Conn. S. W. Dudley, H. M. Turner.

Associate institutional members:

CHRYSLER INSTITUTE OF ENGINEERING, Detroit, Mich., John J. Caton, Director.

MILWAUKEE SCHOOL OF ENGINEERING, Milwaukee, Wis., Karl O. Werwath, Registrar.

UNIVERSITY OF SOUTH CAROLINA, Columbia, S. C., R. L. Sumwalt, Dean.

104 Individuals + 3 Institutional = 107 new members

College Notes

John R. Bangs, formerly head of the department of administrative engineering at **Cornell University,** has assumed his new duties as general manager of industrial and personnel relations of the Edward G. Budd Manufacturing Company.

Bulletin *27*, Iowa Studies in Engineering, is now available from the Department of Publications, **University of Iowa,** Iowa City, Iowa, at $1.65 per copy. This 350-page volume consists of the following papers delivered at the 1942 Conference:

IMPORTANCE OF FLUID MECHANICS

Bakhmeteff (Columbia) and von Karman (Cal. Tech.)

METHODS OF RESEARCH

Tiffany (U. S. Waterways Exp. Sta.), Baier (Michigan), Kuethe (Michigan), Lane (Iowa)

FLUID RESISTANCE

Munk (Catholic U.), Rouse (Iowa), Babbitt & Caldwell (Illinois), Muskat (Gulf Res. & Dev.)

CAVITATION

Mousson (Rustless Iron & Steel), Wislicenus (Worthington), Thomas & Hopkins (Carnegie Tech. & U. S. Engineers)

WAVE MOTION

Mason (Beach Erosion Board), Posey (Iowa), Wexler (U. S. Weather Bureau), Ippen (Lehigh)

FLUID TURBULENCE

Kalinske (Iowa), Thornthwaite (S. C. S.), Knapp (Cal. Tech.)

SEDIMENT TRANSPORTATION

Camp (M. I. T.), Krumbein (Chicago), Einstein (S. C. S.), Landsberg (Chicago)

Rudolph G. Minarik, of the Kimberly-Clark Corporation, Appleton, Wis., has been appointed professor of mechanical engineering at **Syracuse University.**

Items of Interest

52nd Annal Meeting

The 52nd annual meeting of the Society for the Promotion of Engineering Education will be held in Cincinnati, Thursday, June 22 to Sunday 25, 1944, inclusive.

At a meeting of the **Southeastern Section** of S.P.E.E. at Knoxville, Tenn., April 30th and May 1st, the following officers were elected for the coming year:

Chairman: F. L. Wilkinson, University of Louisville.
Vice-Chairman: L. L. Patterson, Mississippi State College.
Secretary: H. G. Haynes, The Citadel.

Nevin E. Funk, Vice-President in Charge of Engineering, Philadelphia Electric Company, Philadelphia, Pa., was elected president of the **American Institute of Electrical Engineers** for the year beginning August 1, 1943, as announced at the annual meeting of the Institute held in Cleveland, Ohio, during the national technical meeting of the Institute. The other officers elected were: *Vice-Presidents* W. E. Wickenden, Cleveland, Ohio; C. W. Ricker, New Orleans, La.; L. A. Bingham, Lincoln, Nebr.; J. M. Gaylord, Los Angeles, Calif.; W. J. Gilson, Toronto, Canada.—*Directors* C. M. Laffoon, East Pittsburgh, Pa. (re-elected); C. W. Mier, Dallas, Tex.; S. H. Mortensen, Milwaukee, Wis.—*National Treasurer* W. I. Slichter (re-elected), New York, N. Y.

Under the leadership of Dean R. G. D. Richardson, **Brown University** has attracted a group of scholars whose work lies in the fields of applied mathematics and mechanics and has set up courses in these subjects in its graduate school which have been given wide attention. As a natural consequence of the work of these mathematicians, Brown is now sponsoring the *Quarterly of Applied Mathematics* to afford a needed outlet for the publication of papers in this field.

The Board of Editors of this new journal consists of Hugh L. Dryden, National Bureau of Standards, Thornton C. Fry, Bell Telephone Laboratories, Theodore von Kármán, California Institute of Technology, John M. Lessells, Massachusetts Institute of Technology, Ivan S. Sokolnikoff, University of Wisconsin, John L. Synge, Ohio State University, and W. Prager, Brown University, *Managing Editor.*

Coördinate Committees on Personal Development

By IVAN C. CRAWFORD, *Chairman*

In coöperation with the E.C.P.D. through Chas. F. Scott, the **Coordinate Committees on Personal Development,** S.P.E.E., have endeavored to determine something about (1) the method of presentation of Wickenden's "The Second Mile" to engineering faculties and students and the reaction to it, (2) the usual method of presenting to students the professional aspect of engineering, and (3) the reactions of instructors to the program.

A letter asking for information on these points was sent to 24 institutions and four individuals, all of whom had ordered copies of "The Second Mile." Eleven replies were received.

Some excerpts from the replies follow:

(1) No definite correlated program of presenting the professional aspects of engineering undertaken in the college as a whole. Wickenden's "The Second Mile" used by individual instructors. Student sections of national societies use for indoctrination purposes.

(2) Used printed material furnished by E.C.P.D. for a number of years in course in Report Writing. Last year used Wickenden's "The Second Mile."

(3) Plan to use "Second Mile" in orientation course given to Freshmen.

(4) A.S.M.E. branch plans to distribute copies of "Second Mile."

(5) Copies of "Second Mile" distributed to senior students through student branches of professional societies.

(6) The chief method which we have used is to bring the professional aspects of engineering before the student is to have prominent and experienced men from industry speak to them.

(7) Series of special lectures given to Freshmen throughout the first two semesters.

(8) Wickenden's "Second Mile" placed in the library.

(9) Freshman year—Engineering Problems—used "Engineering: A Career—A Culture"; now using "Engineering as a Career." Wickenden's article also distributed.

(10) We believe that the most effective method of instilling the truly professional attitude in the minds of the engineering students is through the influence of the individual members of the staff. Therefore, our first concern has long been to secure instructors that do have the professional viewpoint.

From the above remarks it is clear that the professional aspects of engineering are discussed in the student branches of the national societies. Also, in the case of a few institutions this subject is covered in the freshman year at meetings of the class. In the first case, the junior and senior stu-

dents are the ones whose attention is directed to the subject, while in the second case, it is the freshmen who receive instruction.

Quite generally, instructors have emphasized the viewpoint that the professional aspects of engineering should not be treated in a separate course but should be brought into all courses incidentally by the instructor.

The Measurement and Guidance Project in Engineering Education

By R. L. SACKETT, *Chairman, Committee on Student Selection*

The two-year study of selective tests designed to detect engineering talent in high school boys and engineering freshmen ended with the 1942 report prepared by Russell S. Bartlett of the staff of Newark College of Engineering. The second report was printed in the March issue of the S.P.E.E. JOURNAL under the title, "Guidance and Placement of Engineering Students."

The two reports of 1941 and 1942 contained a large amount of suggestive, exploratory material on the effectiveness of the Yale Differential Tests which were given to some 2,000 arts and engineering students. The reports caused an increased interest in such studies and a desire for further critical analysis.

Steps were taken to find a sponsor through whose aid a more exhaustive investigation could be executed. The Carnegie Foundation for the Advancement of Teaching has had considerable experience in the measurement of student achievement. It gave the subject careful study and finally approved a project approved by the Engineers' Council for Professional Development, the Society for the Promotion of Engineering Education and the Carnegie Foundation.

The project as it was outlined has been approved by the E.C.P.D. and by the S.P.E.E. Council at the June convention in Chicago.

Objective.—"The general aim of the project is to discover and apply to the first year of the engineering curriculum those techniques in and applications of educational measurements most appropriate for the selection and guidance of beginning students of engineering.

There are six specific objectives concerned with a pre-engineering inventory of knowledge and abilities possessed by 3,000 to 4,500 entering engineering students; a later achievement examination designed to measure results of entering tests and instruction during the first year; to evaluate results and report to institutions from time to time in considerable detail. Reports will be prepared for E.C.P.D. and S.P.E.E.

A general outline of proposed tests has been prepared and reasons for same are given in the prospectus prepared for colleges which are invited to contribute. A selection will be

made of about ten engineering schools which are interested in the purposes of the project and which are representative geographically of endowed and state institutions, large and small divisions of engineering.

Administration.—There is an *Advisory Council* consisting of the president of S.P.E.E., the chairman of E.C.P.D., the chairman of the two committees of S.P.E.E. and E.C.P.D. concerned with selection and guidance, and Dr. W. S. Learned of the Carnegie Foundation.

The Measurement Committee is the working body which will determine objectives and details of tests and examinations. It will be composed of representatives of the coöperating colleges and universities who by training, education and experience are best qualified to advance the purposes of the project.

The Executive Secretary of the project for the Carnegie Foundation will be a member of the Measurement Committee and will have general charge of the conduct of the study.

The Carnegie Corporation of New York has appropriated $15,000 to assist in the execution of the project. The E.C.P.D. committee has made a contribution of $3,000 toward the cost of scoring and reporting results.

The cost of scoring and reporting will be about two dollars per student and the contribution by E.C.P.D. will reduce the cost to the institution to about one dollar per student.

The arrangement summarized above seems to be an excellent one and unusual since the Carnegie Foundation has not heretofore entered into cooperative agreements. The officers of it have been sympathetic and encouraging in their advice and in the financial aid provided.

How Can We Improve Engineering Books?*

By JAMES S. THOMPSON

Executive Vice President, McGraw-Hill Book Company, Inc.

"In wartime" is a necessary subtitle for this paper, since there are influences of the war in all three phases of the subject, namely, (1) the general format, (2) illustrations, and (3) the style of presentation.

"We" in the title includes the teachers of English in engineering colleges, who are themselves authors or makers of authors of the future. If organized as such they would be an effective liaison between the Society for the Promotion of Engineering Education and the publishers of technical books to help improve the "specifications," so to speak, of these tools of engineering education.

During the same week that Chairman Vaughan asked that this paper be prepared, the Supreme Court of the United States passed formally on the question, "Are authors congenitally irresponsible?" Those are the words of Justice Frankfurter, who delivered the opinion. The case was one of assignment of an author's interest in a copyright. The decision favored the author. Technical publishers will agree that most authors' intentions, at least, are good. Their success as publishers would be greater, however, if every author were well informed on modern illustrating and could capitalize a course in technical writing.

The publisher has been called a catalytic agent, but this is not a perfect designation. The publisher does not always "withdraw unharmed" after bringing together two other units, elements, of agencies. If the perfect catalytic agent is, however, a tough-skinned member of society, then the publisher accepts the title, because his role does indeed make him callous as he observes the clash of opinion among his clientele. Witness, for example, the recent release of a list of suggested books for use in the Army Specialized Training courses—and the embarrassed appreciation by one well-known publisher when he saw that a carefully chosen body of experts in engineering education had selected three titles that had been out of print—from disuse, of course—for years. The publisher should not be blamed then if, in trying to raise his own standards, he becomes at times a cynic.

This paper may be called a cry for help. It is based on an assumption that teachers of English for engineering students have really wider interests than those that might be stirred by that classic dog story from Cornell. "Lie down, lie down," the students in front of Goldwyn Smith shouted in vain to a strange dog that cavorted among them. "Watch now," said one student.

* Paper presented at the luncheon of the Division of English, Society for the Promotion of Engineering Education, Drake Hotel, Chicago, Saturday, June 19th, 1943.

"Don't you recognize him?—belongs to an engineer over at Sibley. Lay Down." And the dog obeyed.

War Influence on Format

The autumn of 1943 will show a direct influence of the war in that both new books and reprints will reflect the attempt of all publishers to carry out the War Production Board's order to conserve paper. The tradition goes overboard that textbooks need ample margins for note taking as well as for artistic appearance. The conventional 4×7 inch type page will appear on a $5\frac{1}{4} \times 8\frac{1}{4}$ instead of a 6×9 inch sheet of paper, and proportionate economies will be apparent in books of other sizes.

Unfortunately, thinner paper may result in halftones showing through the page. The textbook that ordinarily appeared on 65-pound paper (the unit of paper measure is a ream of 500 sheets measuring 25×38 inches) will probably appear on 50-pound paper, and similar reduction in weight down to a minimum of 45-pound will be noted. The over-all results will be to leave more space on the students' shelves and to cause less strain on their arms between classes. For example, Langsdorf's "Direct-Current Machines," 746 pages, drops in weight from 42 to 32 ounces and in displacement from 54 to $32\frac{1}{2}$ cubic inches. Perhaps this is a permanent change for the better. Could the teachers of English sponsor a survey after a year?

Incidentally, to complete the discussion, the student, undoubtedly critical as always of the price he must pay, will think, on seeing this smaller appearing book, that it ought to cost at least a third less. But he will not need his slide rule to discover the disappointingly negative answer. The change for the publisher is only in the cost of the paper, which varies from 6 to 8 cents per pound; *e.g.*, the book referred to will cost the publisher about 3 cents less to produce than it did before. It is the familiar manufacturing story that cost to the ultimate consumer is based more on labor and distribution expense than on materials.

Why must publishers make this change in paper specification? Is there a shortage of pulp and paper? In 1942, the United States consumed 2,200,000 tons of book paper. The United States Government required 500,000 tons; magazine publishers 900,000 tons, of which only 75,000 tons went into business and technical papers. Producers of hard-bound books required 65,000 tons. There are no accurate figures, but it is estimated that technical or engineering book publishers could not have consumed more than 20,000 tons, or less than 1 per cent of the grand total.

Now the War Production Board has directed that for 1943 the paper consumption of every publisher be 10 per cent less than that of 1942—hence the lighter weight and narrower margins; likewise the 1943 conservatism on new commitments. An order for a second cut of 10 per cent, effective April 1, was subsequently withdrawn, but there are warnings that 1944 allotments will be more curtailed than those for 1943.

The technical publisher complies to the best of his ability but is definitely on the spot since, in spite of reduction in sales of his nontechnical items, the demand for engineering books by the Army, Navy, and war industries has caused fantastic records. For some houses in the first quarter of 1943, paper consumption was no doubt 50 per cent greater than that for the corre-

sponding period in 1942. The technical publishers are continuing to add new war books to their lists regardless of the paper rulings. They feel confident that when the WPB officials listen next autumn to their appeal for exemption, a qualitative rather than a purely quantitative approach will be recognized.

These publishers can show how, from their experience, with the editorial advice and guidance of engineering educators, and as good business risks, without subsidies or governmental aid, they can provide these tools which may help to win the war. Wiley and Van Nostrand, with traditions of aid as far back as the Civil War, can point with pride to the importance of war-aid titles that are vital today. Wiley can cite just one example out of many—Brand's "Vectorial Mechanics"—which has been used to train thousands of meteorologists in the new Army Air Forces. Van Nostrand can cite Knight's "Seamanship," which for generations has been unofficially the official text for the United States Navy. McGraw-Hill can mention their unique experience with McIntosh's "Radio Navigation for Pilots" which in manuscript form was frowned upon by an expert in one of the armed services but on publication was at once required in an edition of 40,000 copies for the United States Navy Bureau of Aeronautics.

All technical publishers' lists contain evidence of the vital role their titles are playing in helping to train men in the metal industries, mathematics, radio, production control, aviation, shipbuilding, etc. In order to remain in operation all will have to plead effectively in competition with the religious press, the publishers of detective stories and juveniles—each of whom has a very plausible argument on helping to maintain the morale of the country.

What more can the technical publisher do? Could surveys by the English Division reveal additional methods for paper conservation? What about using smaller type on a two-column page? What size of type is best for students' eyes? What about more illustration and less type? Unattractive examples of what the manpower shortage, which is more to be blamed than pulp shortage, has done to books in England are suggestive of what we may face if the war goes on for years.

The New Emphasis on Illustration

The success today of the picture magazine, the swing to more illustrations in all newspapers and magazines, the increased use of colors in illustration, the proved effectiveness of the strip cartoon in advertising, and now for textbooks the increasing use of visual aids in the form of transparencies, films, and three-dimensional illustrations—all these represent a trend that cannot be ignored by the technical book publisher. They should be of interest also to the teacher of English in engineering colleges. If the author is well informed on processes and possibilities in book illustration, his book will show it. The argument seems natural therefore: Why not include this subject in a course in technical report writing or book manuscript preparation?

Admittedly progress is slow on such matters. For example, exactly 29 years ago the first efforts were made professionally to standardize the presentation of numerical facts and other data by means of charts, graphs, and diagrams. The final result is the current pamphlet entitled "American

Standard Engineering and Scientific Graphs for Publications," sponsored by the A.S.M.E. and approved by the American Standards Association. It should be a great aid to all technical authors in both student and faculty writing, as well as in industry.

To pursue the subject further—would it be practical to offer an advanced course in technical book writing in which there would be a study, in coöperation with the physics, journalism, and drawing departments, of the subject of visual aids for technical books?

How the war has influenced illustration is shown by three examples: (1) Because of the employment of non-technical men and women in the war industries, the inability of the majority to read blueprints has revived interest in relatively unused forms of three-dimensional illustrations, isometric, shaded, and others. Instruction has been accelerated. Books on the subject of production illustration have appeared. The popularity of this form of illustration of machines is evident in its increased use in technical magazines. (2) The United States Navy has found that trainees absorb best printed material that is elaborately illustrated. Some figures are like cartoons. Some make a direct bid for a horselaugh. The life-or-death warnings combine discretion with fun. These Navy manuals are also accompanied by films. (3) A large shipbuilding educational director has found that blueprint reading can be taught effectively by using successive pages of cellophane for related stages of a drawing, in the same manner that a Milwaukee firm * uses acetone sheets for successive representation of examination of the parts of a machine or, in instruction in anatomy, of the parts of the human body.

When such material can be turned out on a mass-production basis their cost will undoubtedly be low enough to make inclusion in books and laboratory manuals feasible. The difficulty for the book publisher is that tradition on book prices is strong. Innovations are possible only if they do not necessitate radical price increases. The question is: Would the teacher dare adopt a book that cost 25 per cent more than before if it contained great aids to teaching such as the above or such as colored illustration that give three-dimensional effects? Publishers today doubt it. Could the English Division sound out faculty opinion on that point?

McGraw-Hill engineering journal editors agree that many articles are especially successful because the authors have, first, an excellent sketch or photograph and, second, an appealing descriptive legend which hooks the readers' interest in the articles. Is this, also, a clue for book improvement?

The Bane of Excess Verbiage

We come now to the basic point of contact between the engineering book publisher and the Division of English of the S.P.E.E., and should first dispose of a fundamental question. Is the speaker qualified to discuss style? Has he written an engineering book? Any book? Has he taught a class in English? The answer to each of these questions is definitely no. In general his authority is largely based on years of contact with authors, on experience as a buffer between critics and authors, and as a reviewer of book reviews and of comments on technical books. More definitely, however, three reasons may

* Milprint, Inc., producers of "Transmission."

be mentioned for warranting his temerity in attempting to discuss style. The first is his opportunity to quote a person who has probably prepared more technical book manuscripts for the printer during the last ten years than any other person in America, second, his permission to quote an author whose unique success in writing is largely based on his ability to overcome what everyone seems to agree is the bane of technical writing, namely excess verbiage; and finally, his opportunity to present the opinions of some of the 150 odd editors of McGraw-Hill engineering journals.

(Current directives from Washington might suggest that law, instead of engineering, schools need courses in report writing. Who ever heard of 200-word sentences in engineering papers? A Stone and Webster engineer showed the speaker a WPB Utilities Order of February 24, 1943, which contained two such endless sentences. One wonders how the legal minds that dashed them off expect the engineering operators to interpret quickly and correctly their many qualifying and parenthetical phrases.)

Let us assume that the author's general idea has been approved; the publisher believes it will enhance the house's reputation and perhaps be commercially feasible; the work is projected as to size and as to number, and character of illustrations. The author and publisher agree on general format. The experts finally report technical accuracy and modern, comprehensive treatment. Finally the document is turned over to the Production Department for styling, *i.e.*, for making sure the author has been consistent in spelling, abbreviations, footnotes, cross references, and all the minutiae of technical presentation that help the student or research worker to absorb the text with the minimum of effort. What is the most common problem?

First, to quote the expert:

"Too many manuscripts on scientific and engineering subjects are burdened with excess verbiage. The subject matter, being itself exact, calls for efficiency in the use of words, but the weakness of the average manuscript is due partly to unintentional repetition, but more to a lack of precision and logical development within individual sentences and paragraphs.

"In the interests of efficient publication three procedures are recommended: (1) that the author submit a table of contents in outline form, showing by means of indention the relative value of the headings: (2) that in fields where the terminology is changing the author choose, early in the writing, the terms he wishes to adopt, whether 'conductance' or 'conductivity,' 'reflection' or 'reflectance,' 'luminance' or 'luminosity'; (3) that the author follow a consistent style of abbreviation, preferably in accordance with the ASA or other approved standards."

These statements were submitted on request by Miss Elizabeth Gile, in charge of the Styling Department of the McGraw-Hill Book Company, whose considerable experience is referred to above. She recommends for the average author the United States Geological Survey, "Suggestion to Authors," which she says gives, in "palatable form," practical suggestions for the man whose interest is primarily in engineering rather than in writing.

Second, to quote an author on this problem: It is Professor E. H. Schell, of the Massachusetts Institute of Technology, whose ability to write compactly has been a factor in the success of his books. When asked his technique, he replied, and gave permission to quote as follows:

"Perhaps all that can be said is that condensation and clarification are two independent responsibilities of the author, which follow upon the placing of his thoughts on paper.

"I have always tried to write or dictate at least 25 to 35 per cent more of material than I ultimately intend to use. Fifty per cent is a much better figure. Clarification then follows, which in my case usually is assisted by re-designing my sentence structure from third person passive into second person active.

"Final condensation thrives best on a sense of active irritation with onself for becoming so wordy. With one's dander sufficiently aroused a fair job of slashing can take place on the first round. At this point the most valuable assistance is an independent critic who will search aggressively for opportunities for criticism.

"This process is always painful for one always hopes that the first draft will be perfect: but it never is. The sequence of attack does seem to rob the process of improvement of some of its difficulties."

Third, to quote the engineering journal editors: It is possible to use only a fraction of the answers to this speaker's question, "What has a technical editor to suggest to the teachers of English in the engineering colleges?" "Excess verbiage," "vocabulary development," "cultural values," "Arts college vs. engineering college emphasis" —all the much discussed agenda of a regular S. P. E. E. divisional meeting were found in the memos of these editors. They apparently sense from their practical daily work the same problems as the teachers.

Colonel W. T. Chevalier, publishing director of *Business Week* and at one time editor of *Engineering News-Record*, says there are two kinds of technical writer: (1) Those concerned solely in getting words out of the head and onto the paper, and (2) those whose words are so well presented that they promptly get off the paper and into the reader's head. "It is the latter who can make a good living at writing," he said. "I would have all engineering students fully exposed to the classics, including Shakespeare, not to attempt to duplicate, but to realize the possibilities and to contrast the qualities of the classics with the average of our writing. It should also help the vocabulary development, which is important both for reading understandingly and for writing. A test for vocabulary development, if I were a teacher, would appear indirectly in requiring a student to cover a subject for more than one level of intelligence. For example, the Tacoma Bridge failure would be covered in three different themes, one for publication in the *New York Daily News*, one for appearance in *Harper's Magazine*, and one for the proceedings of the American Society of Civil Engineers."

P. W. Swain, editor of *Power*, one-time teacher of engineering at Yale said:

"From long observation of engineers I would make the following comments:

"1. More than any other one thing, the ability to use the English language distinguishes the successful engineer from the unsuccessful.

"2. In general, engineering writing is unnecessarily stiff, involved, and long-winded.

"3. In teaching engineering, I suspect English teachers naturally turn to the published papers of well-known engineering practitioners. However, many of these papers are not proper models—too many long words and too much stiffness. Teachers of engineering English should stress at all times the virtues of one-syllable words and simple and direct statements."

Swain's 22 rules for editing, published in the April, 1943, issue of the *College Publisher,* contain such thoughts as this: "Work hard at writing to make reading easy."

F. A. Annett, also of *Power,* referred to the March, 1943, issue of his journal and C. M. Ripley's article on "Short Words Carry a Punch." The editor's subtitle is "Shakespeare and Kipling agree. Here's one secret of good writing and good talking for every big or little engineer who'd like to go places. Long words are the bunk." Annett quoted the late Fred Low, editor of *Power* for over 40 years, who often said, "I can always cut the first paragraph off any article and improve it." Annett's prize editorial experience was with a contributor who had agreed to do a 3000-word article on mechanical power transmission. The author protested that the space allotment was too brief, so Annett doubled it—"just to see what would happen."

"In due time two articles came along. Each consisted of twenty-three 8½ × 11 closely handwritten sheets. Editing excess verbiage out of these stories made them into two very excellent articles. But please note that the author, in 46 pages of closely written material, never got to the subject he was supposed to write about."

Archer E. Knowlton, of *Electrical World,* speaking of his philosophy of technical writing—"to get authors to differentiate between writing for immediate practical consumption and writing for posterity, sternity, and the archives of the professional societies"—gave me the following item. It is part of some General Electric News Bureau advice to writers:

"Writing an article should be no more difficult than telling your favorite story—if you will write it as naturally as you would tell the story. What is equally important, it will be interesting to others.

"Have you ever wondered why some article particularly 'clicked' with you; why you understood exactly what the author was driving at, and why his explanations left a clear picture in your mind?

"Such articles usually have three things in common:

"First, they get right into their subject without the necessity of wading through an introduction of platitudes.

"Second, they take that one subject and work on it alone. There are no detour sentences or paragraphs that are not directly connected with the subject and that don't help develop it in a logical manner.

"Third, the article ends when the subject, or the particular phase of it that is being discussed, has been covered."

Dr. H. C. Parmelee, *Engineering and Mining Journal,* one-time President of the Colorado School of Mines, referred to his paper, "Some Notes on Technical Writing," published in the *Colorado School of Mines Magazine* for February, 1913. In this he quotes a large employer of college graduates with comparisons between the kind of training in English which the arts and the engineering college graduates receive.

"I am not assuming exaggerated conditions in laying so much stress on well-written reports. The engineer of a large company has published his experience with such reports, and I give it to you because it throws a great light on the fundamental criticism of technical training, namely, that it fails to produce men of broad cultural attainment. It has a further value in showing the prevalence of poor writing among technically trained men. Three hunderd reports were examined by this engineer, who undertook also to investigate the training and his-

tory of the men who made them. I quote from his experience, as follows:

" 'Eliminating those (reports) made by what we term "self-made men," and those whose record and training I was unable to trace, and considering alone those coming from graduates of technical schools, I could show you an almost unbelievable ignorance of even the most recent history; and absolute disregard, if not ignorance, of the simplest laws of medicine, of hygiene, of morality or common honesty; and when it comes to logic, and the use of our wonderful heritage, the English language, I am at a loss for words adequate to describe the facts. If clear writing is necessarily preceded by clear thinking, then a large body of technically trained men is hopelessly lost in the fog.

" 'In marked contrast to this stands out the clear, concise and logical work done by every one of the 27 men represented in these reports whose technical work followed a liberal arts or classical education. This may be due in part to the fact that the liberal arts man who takes up technical work does so usually because of a great and mature love for it, or for some equally strong motive, and he therefore should not be considered in the comparison. True, yet we have surely an equal right to expect from every technically trained man the same or greater love for his calling, and an equally strong motive for his entering the chosen profession.' "

Keith Henney, editor of *Electronics*, added this bit:

"I think technical books should and could be more interesting. I remember the jolt I got when I first read a book by a fellow named Andrade, a scientist who explained heterogenous radiation as like the sounds issuing from a piano when you threw it downstairs. Here was a scientific boko that woke you up, not put you to sleep. I read the whole darn book, and I am sorry to relate that never again did the author let himself go. I was disappointed, needless to state."

S. D. Kirkpatrick, editor of *Chemical and Metallurgical Engineering*, referred to the McGraw-Hill "Editor's Manual," which offers the cub on the staff the following eight points on "Writing for the Business Paper":

"Good Writing Essential

"To the business paper, good writing is vital. Its message must be transmitted clearly, tersely, and forcefully, without ambiguity or chance of misinterpretation. Its readers are busy, and demand that the information or thought conveyed come to them easily and definitely, with all conditions and implications readily apparent.

"Write Simply and Briefly

"The best style is the style that you do not notice. It clothes the thought so smoothly that one is not aware of 'style,' at all. 'The highest art conceals art.' Beauty has been defined as perfect adaptation of form to purpose, and the definition applies pre-eminently to beauty in writing.

"These are universal principles. They apply with full force to business paper writing. An arty, florid style is bad enough anywhere. In a paper that aims at usefulness in a practical world it is intolerable. So is hasty slovenliness. So is the unnecessary word. Write simply and briefly!

"Good Writing Means Hard Work

"Clear and forceful writing requires hard work. Even the skilled editor will often find that his first draft does not convey his thought effectively to one of his colleagues. A good principle is this: Whatever is worth writing for the business paper is worth revising, rewriting, and re-revising. The secret of easy reading is unremitting effort in writing. It is a known fact that material most easily read is longest remembered. Read aloud

to yourself what you write, or read it to an auditor. You are likely to be astonished at the awkward spots you will catch in this way.

"Constant Training Is Important

"Skill in writing reduces the labor required to make an article effective, but skill itself is obtained only through effort and practice. Good writers are not born; they are made by hard work. It should be the editor's constant aim to perfect his writing ability. Thinking with precision, cultivating simple and direct statement, and reading the works of masters of literature are helpful.

"Two Useful Principles

"Two principles of good writing are: *First,* do not confuse or strain the reader's mind by using a word in a secondary sense when it has a different meaning in its primary sense. *Second,* avoid repetition of words and phrases except when iteration is used for emphasis. Repetition is tiresome and confusing, and carries the impress of poor writing. This same thing is true of monotony in form: the repeated use of the same construction, as when several consecutive sentences open with a participial phrase, or are of inverted construction, or begin with 'the.'

"Do Not Use Rubber-stamp Language

"Avoid the hackneyed phrase, which is usually the symptom of absence of thought, mental laziness, or profound insensitiveness to the art of words. When these 'rubber-stamp' phrases come into the writer's mind, they should serve as immediate warning of the dangerous approach to careless writing.

"Avoid Artificial Forms

"A further caution is that abnormalities and tricks of language should be avoided. Thus, where repetition of a word or phrase is logical it should not be evaded by recourse to strained consrtuction or uncommon phrasing. This applies with special force to the use of the definite article as the first word of a sentence. Remember that many statements naturally begin with the subject: never omit 'the' when good usage calls for it.

"Again Brevity and Simplicity

"To repeat, brevity and simplicity, associated with clearness, are the prime qualities of good writing. All technical subjects involve complexities, and their language, with its special terms, easily becomes complicated and awkward—even unintelligible. The editor's task is to make the language simple.

"A good editor may be judged by what he deletes. Remove all obstacles to easy and unambiguous understanding: simplify construction by elision of unnecessary words and purposeless punctuation. To judge of punctuation, read the sentence aloud rapidly: if you have to pause where no punctuation mark appears, add punctuation or recast the sentence.

"Break up involved and loosely joined sentences. Supply words of reference, causation, or interrelation. Paragraph properly, limiting each paragraph to a single thought or group of thoughts. See that the reader's thought can pass readily from the conclusion of one paragraph to the opening of the next."

To Supplement an S.P.E.E. Report on English

To return to a war atmosphere and Colonel Chevalier's reference to vocabulary development: In the June, 1940, S.P.E.E. report on "Instruction in English in Engineering Colleges," the statement is made on page 96, "Weakness in vocabulary is a point that has brought frequent criticism upon engineers, but hardly an institution mentions any course designed to correct this fault."

To this discussion a supplement is herewith submitted:

Some years ago, close personal contact with a new cadet at West Point revealed the astonishing fact that he was virtually memorizing the front matter of a sizable dictionary and apparently understanding the elaborately expressed material on symbols, pronunciation, orthography, and abbreviations. (This speaker must confess at this point to being initiated also then and there to some new subject matter.)

Asked currently, therefore, as to the present existence of and background for this practice, Colonel Clayton E. Wheat, Professor of English, reported in April, 1943:

"It is true that we lay great stress upon the use of the dictionary in our course here at West Point. We hold that clear expression of thought requires a vocabulary of around ten thousand words. A study of the various vocabulary tests taken by the candidates for the Military Academy indicates that the average vocabulary of these candidates is between six thousand and seven thousand words. To meet this deficiency the Department of English has instituted corrective measures which include the study of the dictionary and vocabulary building exercises.

"Our first lesson to the incoming class is one on the use and value of the dictionary. From this first lesson, on throughout the course, the use of the dictionary is constantly being emphasized by all of our instructors. The cadets soon learn the importance of the use of the dictionary when they find they are suffering a very severe grade penalty for the misspelled words in any of their written work.

"During the year we complete an applicatory vocabulary building course consisting of twenty-four lessons. During these lessons the use of the dictionary is again encouraged.

"The results of a final vocabulary test, based on a four-year study, indicate that all cadets have greatly improved their vocabularies.

"A very interesting fact which justifies our emphasis on both dictionary and vocabulary work is revealed in a comparison of the initial vocabulary test and the monthly academic standing. We find that the academic standing of cadets in English varies almost directly with their standing determined by the vocabulary test. A graph of their vocabulary test is almost identical with that of their academic standing."

From the United States Naval Academy, Captain R. A. Hall, Head of the Department of English, reported also:

"Each midshipman is required to possess a copy of Webster's Collegiate Dictionary.

"By a departmental regulation, he is required to know the meaning of all words occurring in the class assignment for the day. It is the frequent practice of the instructors to call for the meaning of various words in the day's lesson.

"Furthermore, the section leader in charge of each group (twelve to sixteen midshipmen) is required to bring his dictionary to each recitation of his group. In the classroom full use is made of it both by the midshipmen and by the instructor."

It is certainly appropriate to report, also, the quotation from John Paul Jones (letter to the Marine Board, 1777) printed on the midshipmen's English fall and winter term sheets which outline the courses:

"None other than a gentleman, as well as a seaman both in theory and practice, is qualified to support the character of a commissioned officer in the Navy; nor is any man fit to command a ship of war who is not also capable of communicating

his ideas on paper in language that becomes his rank."

And also Secretary (Publisher) Knox's statement which heads the spring term sheet:

"I would go so far as to say that the ability to use clear, concise, and forceful English in speech and in writing underlies and reinforces efficiency in any and all branches of the Naval Service."

If speculation is appropriate for an S.P.E.E. paper, one may consider whether the dictionary practices for the service schools may well be studied by this division and recommended to others.

Return to the Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

Society for the Promotion of Engineering Education

Date.....

The undersigned desiring to become a member of

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hereby agrees to conform to the requirements of membership, if elected, and submits the following:

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